U.S. DEPARTMENT OF COMMERCE/National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

PROCEEDINGS

FOR THE

WEATHER INFORMATION FOR SURFACE TRANSPORTATION:
DELIVERING IMPROVED SAFETY AND EFFICIENCY FOR TOMORROW
SYMPOSIUM

November 30 - December 2, 1999

Holiday Inn

Silver Spring, Maryland

OFFICE OF THE

FEDERAL COORDINATOR
FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

8455 Colesville Road, Suite 1500
Silver Spring, Maryland 20910

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Washington, DC
February 2000

FOREWORD

The "Weather Information for Surface Transportation (WIST): *Delivering Improved Safety and Efficiency for Tomorrow*" symposium was held on November 30 - December 2, 1999, at the Holiday Inn, Silver Spring, Maryland. An unprecedented cross-section of more than 120 transportation and weather professionals representing federal, state, and city governments, urban and rural transportation agencies, professional and trade organizations, and weather services providers (government and commercial) attended the plenary sessions and three workshops. Keynote speakers were Dr. Stephen Van Beek, Associate Deputy Secretary of the United States Department of Transportation, and Dr. D. James Baker, Under Secretary of Commerce for Oceans and Atmosphere and the Administrator of the National Oceanic and Atmospheric Administration (NOAA).

The goal of the symposium was to provide a forum leading to the establishment of <u>national</u> needs and requirements for weather information associated with the decision-making actions involving surface transportation. This goal is consistent with a major theme of the historic Transportation Equity Act for the 21st Century. Secretary of Transportation Rodney E. Slater, in his summary message, stated "*...transportation is about more than concrete, asphalt, and steel…it is about people, and about providing them with the opportunity to lead safer, healthier, and more fulfilling lives.*" The WIST symposium was a significant step toward achieving this goal.

This document summarizes the proceedings of the WIST symposium and captures the recommendations from the breakout sessions. An analysis of the WIST questionnaire and a requirements document will be released later this summer.

In conclusion, I wish to thank the United States Department of Transportation, Federal Highway Administration for helping co-host this important and highly successful event. I am indebted to the membership of the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) and the Joint Action Group for Weather Information for Surface Transportation (JAG/WIST) for their support and guidance. Finally, I wish to express my deep appreciation to the WIST participants whose contributions provided significant impact. Without you, our ability to identify and resolve specific, time-critical issues and projects would be jeopardized.

Samuel P. Williamson
Federal Coordinator for Meteorological Services
and Supporting Research

PROCEEDINGS

of the

Weather Information for Surface Transportation:

Delivering Improved Safety and Efficiency for Tomorrow

Symposium

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Remarks prepared for Delivery by

The Honorable Dr. Stephen D. Van Beek, *Associate Deputy Secretary of Transportation*

During the

Symposium on Weather Information
for Surface Transportation
Delivering Improved Safety and Efficiency for Tomorrow

Thank you, Sam (Williamson), and good morning everyone. And thank you for attending our first major meeting on weather information for surface transportation.

Charles Dudley Warner, an African American writer and co-author of *The Gilded Age* with Mark Twain, once said, "Everybody talks about the weather, but nobody does anything about it!" And I had sworn to myself that I wouldn't use that oft-used quote today. But, upon reflection, I decided it sets the right tone for this morning's agenda.

We can't control the weather (at least not yet!), but we are doing something about it in terms of actions to improve safety and mobility in inclement weather. As Sam said, we have been working with our meeting co-sponsors, the National Oceanic and Atmospheric Administration (NOAA) and the Office of the Federal Coordinator for Meteorology (OFCM), to develop improved and better coordinated weather forecasting for surface transportation. We appreciate their leadership and involvement and look forward to working with them to see a national weather information system for surface transportation put into place.

Dr. James Baker is our other keynote speaker, and I look forward to hearing what he has to say about the issues and the challenges involved. He's a strong partner in many of our aviation and maritime activities, and I'm happy to extend that partnership to surface transportation as well.

Why Weather Forecasting for Surface Transportation?

Today, I am going to focus my remarks on why it is important to improve weather forecasting and warning systems for surface transportation, and what kind of coordination is needed for success.

Traditionally, the focus of weather forecasting has been on conditions in the atmosphere and general precipitation, with only the most general information on road conditions. We've all heard local weather updates or news anchors say that roads are "slick" in places or are "passable". DOT believes that safety, mobility and productivity can be greatly improved by providing the public with: (1) information that is route-specific; (2) more accurate near-term weather predictions; and (3) reports about conditions that specifically affect the decisions surface transportation users and managers make. This is equally true for both roadway and railroad track bed conditions and waterways.

Providing weather information for surface transportation is a multi-step process. It starts with the excellent foundation of national and commercial weather service products, which can be tailored into the specific types of road-weather information that best meet the needs of users, whether they be travelers or a maintenance crew. Pulling together and communicating this information requires extra work and coordination on the part of both the weather and transportation communities from both federal and state agencies, many which are represented here today. We believe that joint programs with the Department of Commerce for observational systems and enhanced products are needed.

While detailed weather forecasting for surface transportation will certainly benefit metropolitan areas, it's also true that the roads and railroad tracks of rural America, where most of America doesn't live but where many travel, would benefit from improved road-weather information.

Having better weather information is not just a matter of convenience -- it is about saving lives. Each year in this country, we have an average of 6,500 fatal roadway crashes occurring during bad weather, which are about 17 percent of all fatal crashes. Of those, 60 percent happen in rural areas, primarily on non-interstate roads. But even the interstates can be affected, as we saw in last weekend's huge bus crash on Pennsylvania's I-80, where 4 chartered buses followed each other off the road with fatal consequences.

In addition to travelers, snow plow drivers and other maintenance staff could benefit from better weather and road condition information. We have found through research that if storm maintenance crews knew more about road conditions ahead of time, they could cut snow removal operating costs, particularly for materials and labor, by about 10 percent. Given that about $2 billion is spent each year on snow and ice control, that's a potential taxpayer savings on the order of $200 million.

Detailed weather forecasts for surface transportation could also help traffic managers, school administrators, transit, and commercial truck operators.

We believe that we can -- and should -- use weather forecasting to prepare people better for trips by truck, train, and commuter rail. We benefit from this information when 16 percent of us travel by plane, so why not do the same for the 84 percent of us moving on surface transportation? We have an extensive aviation weather program and our FAA maintains close working relationships with the OFCM and the National Weather Service. For this reason, we have tangible products and services such as terminal and route forecasts that serve needs for safety and optimal flight planning. The FAA and National Weather Service participate in joint programs for observational systems and weather services for aviation in the National Aviation Weather Center and the Center Weather Service Units. These joint programs provide weather support to air space users and air traffic controllers over the entire airspace system.

Right now, we don't have that kind of comprehensive and reliable capability for our surface transportation system, but the latent demand is there. People are showing an interest in smart vehicles that can anticipate problems and help them decide to take alternate routes. Millions of people who log onto *Weather.com* and similar websites are looking for travel-related weather information so they can anticipate hazards and make their trip safer and less stressful.

Christine Johnson and others in the Federal Highway Administration (FHWA) think that weather forecasting for surface transportation is a good idea and have reached out to the OFCM and the NOAA weather experts. They, too, thought it was a good idea. So, now we have a Joint Action Group (JAG) to define the needs and to coordinate efforts toward developing a national weather forecasting system for surface transportation.

Developing solid weather forecasting for surface transportation - highways, rail and transit - will require a broad and strong public/private partnership to make it work. Many state DOTs are already developing weather forecasting systems for surface transportation, particularly in mountainous and storm-prone regions. Several multi-state initiatives are bringing ITS together with advanced weather prediction systems to create operational highway management and traveler information systems throughout North America. These programs envision a widely accessible road and weather information system that will support seamless information sharing for travelers, highway maintenance managers, and transportation operations managers.

Hurricanes demand attention because of their impact on coastal developments, beaches, and, of course, roads and highways. Emergency managers and travelers depend on road condition information before and during hurricanes because escaping the path of the storm could mean life or death. Not only do they need to know if the roads are open, but also if the roads have reached capacity.

In the case of Hurricane Floyd, the transportation system became overloaded, with some people taking 18 hours to reach shelters. While this took less time than the road models predicted, the public found the delays unacceptable. They think we could do much better, and they are probably right.

Some states are moving ahead with specialized road and weather information systems. Washington State transportation officials report mountain pass road weather conditions on the Internet to help travelers. One official noted: "After getting 10 million hits on the website during the 1997-98 winter season, we discovered the traveling public has a voracious appetite for road and weather condition information." Thus, Washington State DOT joined a consortium of agencies that need weather information and, together, they are implementing a system for providing travelers with more and better weather information. Washington State recently installed an automated weather station for state ferries that cross the Puget Sound.

Another initiative sponsored by the Federal Highway Administration and the North and South Dakota DOTs is the Advanced Transportation Weather Information System (ATWIS). This system is the first rural road condition information and weather forecast in-vehicle system in the United States. Very specific local forecasts are made available to cellular phone users through a computer telephone system that queries them about their location and their direction of travel. During one snowstorm, the system can accommodate up to 2,000 calls.

It's not surprising that technology will play a key role in developing a system that provides accurate, tailored weather and surface transportation information. And, DOT's ITS program is working to bring the technologies together with the communication systems we have in place. We are collaborating with industry, universities, and other research organizations to provide the vehicle technologies and the mechanisms to get the right information to the right people at the right time.

One example of our efforts is the new Dedicated Short-Range Communication (DSRC) ruling by the FCC, which will enable providers to send route-specific road condition information directly to the vehicle. We are working with state and local transportation officials to employ sensors to detect road and weather conditions for better and more efficient winter road maintenance, particularly in northern states.

Everything we are considering is not necessarily expensive or high tech; many weather-related solutions are low-tech and practical. For example, at bridges and overpasses or sites where ice tends to form, we can install detectors connected to electronic signs that warn drivers of the icy conditions. This solution is both simple and inexpensive.

The Federal Transit Administration (FTA) plays an important role in the Department's efforts to improve weather information for surface transportation. FTA is working with the Federal Highway Administration and the other modal administrations to encourage deployment of Intelligent Transportation System technologies to improve rail and bus transportation system management.

FTA is working with ITS to develop and deploy Automatic Vehicle Location systems based on Global Positioning Satellites and Geographic Information Systems to keep buses, light rail, and pedestrians safe. They are also using variable information signage, and automatic passenger counting data streams to assess fleet management strategies.

FTA is currently testing a remote sensing device in Las Vegas, Nevada, to improve the air quality attributed to the pollution and dust from the Los Angeles air basin and the San Joaquin Valley. FTA has also implemented an air quality model called TRANSIMS (Transportation Analysis and Simulation System), which analyzes air quality and emissions impacts from transport using National Weather Service data.

Conclusion

Now is the time to invest in infrastructure improvements like ITS for weather forecasting because we have the strongest Post-Cold War economy.

Since 1993, President Clinton and Vice President Gore have led America in preparing for the 21st Century. Under their leadership, we have a balanced budget, nearly 20 million new jobs, and the lowest unemployment in 30 years.

With such a strong economy, we have the opportunity to invest in America's infrastructure and create a transportation system that will help us continue to prosper as a Nation.

President Clinton and Vice President Gore understand the connection between upgrading our transportation infrastructure and growing our economy. Under the Transportation Equity Act for the 21st Century, we will invest more than $200 billion to upgrade our transportation system over the six-year life of the law. This year alone, the ITS program will receive $211 million in funding. Of the $98 million allotted to ITS research and development, the Weather and Winter Mobility program will receive about $2 million.

This is an opportune time to improve both safety – DOT's number 1 goal -- and mobility -- our 2nd most important goal. So, let's work together and communicate often at forums like this one.

DOT will collaborate with the OFCM and the National Weather Service to make the case for investment in our Nation's weather information system. Two critical foundation pieces are already ongoing -- the National Weather Service modernization and DOT's investment in Intelligent Transportation Systems. Let's find ways to maximize these investments to achieve our safety, mobility and productivity goals. Further, we want to develop an *esprit de corps* across all the key parties - the meteorological community, the surface transportation community, the public agencies, and the private industry -- toward the end of safer surface travel.

Our ultimate goal is one the American people will, I hope, understand and applaud - to develop a national weather information system for surface transportation that will make travel safer and more efficient for the public we serve.

Thank you.

Remarks prepared for Delivery by

The Honorable Dr. D. James Baker, *Under Secretary of Commerce for Oceans and Atmosphere*

During the

Symposium on Weather Information
for Surface Transportation
Delivering Improved Safety and Efficiency for Tomorrow

Good morning. Thank you for participating in this very important symposium, which recognizes the first-ever alliance, at the federal level, of the transportation and meteorological communities.

NOAA is delighted to work with all of you to integrate weather products and services in a way that will bring critical information home to everyone in America – whether that means learning about weather hazards while operating tractor trailers or when docking ships, seeing them graphically in cars, or getting alarms about approaching flash floods over the 24-hour NOAA Weather Radio network.

The challenges – and opportunities – belong to both the public and private sectors. The key is to combine our shared knowledge and resources, and to put them to work for a safer, stronger Nation.

Under DOT, Secretary Slater, Associate Deputy Secretary Van Beek and their staffs have organized a series of key initiatives. These have brought us a vision and a framework for improving the safety and efficiency of current and future transportation systems. I am pleased to recognize the work of the Federal Highway Administration in drawing attention to weather information needs for surface transportation.

At NOAA, we are fortunate to have the committed leadership of Sam Williamson. Sam directs NOAA's Office of the Federal Coordinator for Meteorology – a co-sponsor of this symposium.

Both the operational and developmental sides are paramount in developing improved and better-coordinated weather forecasting for surface transportation. On the operational side, we have the National Weather Service; private weather companies that are facilitating the flow of weather data to the media and tailoring it specifically for railroads and trucking and agricultural needs, among others; and the media itself.

On the developmental side, the National Research Council under the National Academy of Sciences is focusing the efforts of our communities on developing and improving intelligent transportation systems through the Transportation Research Board. There are also 16 university transportation centers looking at such developmental areas as road weather, alternative fuel, and research for intelligent vehicles and highways. And the National Center for Atmospheric Research is examining technology aimed at factoring meteorological data into decision-support systems.

Already, designers and providers are better able to integrate weather information – and everyone will benefit, in both the public and private communities. Effectively integrating weather information, for example, means that we can also make better use of our pipelines because temperature changes impact not only consumption, but also the flow of oil and gas.

Our entire transportation system comprises 11 percent of the Nation's GNP…internationally, over $200 billion in trade is accommodated by various transportation systems.

And, of course, beginning with the Roman Empire's intricate road system, the protection of our transportation systems is vital to national security. Winston Churchill said, *Victory is the beautiful, bright-colored flower. Transport is the stem without which it could never have blossomed.* In the United States, safeguarding our interconnected highways, waterways and air transport is key to the success of our national defense.

Just as transportation is a determining factor in our lives, so is weather – a look at the 20th century's most devastating weather and climate events bears this out.

In 1992, Hurricane Andrew became the nightmare South Floridians had long-feared; a Category – 4 storm barreling into one of the East Coast's most populated areas.

Making 250,000 people homeless, and causing $25 billion in damages. Andrew is the costliest hurricane to hit the United States this century. Transportation was indispensable to the evacuation and recovery efforts of the Red Cross, FEMA, and many others.

For the East and Northeast, the Superstorm of March 12-15, 1993 produced a snowfall as widespread as any in this century. Hundreds died and, for the first time, weather shut down every major airport in the affected regions.

Midwest floods in 1993, and in the Pacific Northwest in 1998, also brought devastation…many of you will recall that, in 1998, ice storms immobilized New England.

And as you can see on this FEMA map, nearly every state experienced some form of weather-caused disaster in 1999…from ice-coated power lines in New England, to fires in Florida, and hurricanes, tornadoes, high winds, floods, and severe freezes in other parts of the country.

These disasters not only stun us with their ferocity – they reveal the growing sophistication of our professions and society in learning to cope with nature's impressive powers. Among the destruction are major success stories:

The 1993 Superstorm marked a watershed in multi-day weather prediction. Computer models did an excellent job of predicting the storm's strength and track, and the heavy snows were forecast days in advance. As a result, the airline and trucking industries used alternative routes and succeeded in relocating assets out of harm's way.

Six months before the 1997-98 El Niño became a household word, our monitoring buoys detected a pool of warm water spreading across the Pacific Ocean. Early warnings reduced human loss and suffering, and marked the greatest triumph of long-range forecasters to date. With new tropical observing systems, satellites, and better science, the dramatic temperature shifts in the equatorial Pacific Ocean and accompanying weather changes were remarkably consistent with expectations. We can contrast the six-months' heads-up for the most recent El Niño with what we didn't know when the previous El Niño hit in 1982-83, causing tremendous damage across the United States. El Niño, in fact, was a little known phenomenon at the turn of the century.

And when one of the most intense tornado outbreaks possible overtook Oklahoma City this past May 3, the National Weather Service provided a remarkable 32-minute lead-time average for the first warnings issued in every affected county. Weather service products signaled the potential for severe weather as early as 36-hours prior to the outbreak.

Oklahoma City provides an outstanding case study of a natural disaster reduction operational process in action. Federal, state, and local partners, including the media and amateur radio operators, evoked effective and timely responses, and shaped positive outcomes that would not otherwise have occurred. Transportation was crucial in relocating people ahead of the tornadoes, and in providing medical assistance and recovery following the tornadoes.

We know of an instance in which a company owner heeded forecasts and kept his employees on-site. The forecasts – and his decision – saved lives.

We are pleased that, by 1998, the National Weather Service provided both longer lead times and more precise forecasts for both tornadoes and floods. This graphic shows the improvements over the past 5 years.

But while we are better prepared than ever, we are also more vulnerable than ever. Especially vulnerable are our fragile, and increasingly populated, coastal areas and the economies – national and local – that depend on them. With over 50 percent of our population now living and working within 50 miles of the coast, and about 3,600 more people moving to coastal areas every single day, safe, efficient transportation systems and effective weather forecasting will only grow in importance.

America depends of healthy coasts. Coastal communities bring in over 30 percent of the GNP. The Nation's $20 billion-a-year fishing industry depends on healthy marine habitats and diverse ocean life.

But already we are changing the chemistry of our waters. All along our coasts, polluted runoff is the major source of water pollution. Emissions, too, are of great concern. Environmental impact statements and transportation control plans will go some distance in helping to mitigate these critical concerns.

Our fast-changing world is also more wired that ever and this, too, makes us more vulnerable. We're now headed into another Solar Max cycle, a time of intense solar activity when we can expect increasingly turbulent space weather. You may remember how, during the last Solar Max, the Province of Quebec went dark because a geomagnetic storm caused power lines to overload.

Geomagnetic storms can impact power grids which, in turn, can directly impact rail and transit dependent on electrical power sources. Even if this kind of storm hits hundreds of miles from your location, it can generate excess current that has the potential to burn out transformers, trip circuit-breakers, and disrupt electrified rail systems.

NOAA's Space Environment Center in Boulder monitors the solar environment around-the-clock with a complex array of ground-based observations and satellites. And earlier this month, we introduced the first-ever space weather scales. These scales were developed in Boulder, and we call them the Richter scales of space weather. The scales are designed to characterize the severity and impact of upcoming solar storms on public safety and services.

Much has been accomplished. But, together, we still have a tremendous amount to do. It's not a matter of who gets a piece of the pie, but rather how we can pull together to do a better job. No pilot takes off without first getting a briefing – and we must begin to provide similar safeguards for all forms of surface transportation.

It will take public and private partnerships to tackle the concerns, particularly since vulnerability to weather increases as new technology becomes embedded in our transportation systems. Together, we need to provide better support to decision-makers so that people and property are safely and efficiently kept out of harm's way.

I am pleased that NOAA is supporting improvements in the planning, design, and safety of transportation – and in ways that benefit both our environment and the economy. The building blocks of our efforts are observations, numerical models, forecasts, and warnings. These efforts provide the basis for specialized weather services that tailor data for transportation systems.

Exciting technological breakthroughs in satellites, radar, sophisticated information systems, automated weather observing systems, and super speed computers shape up-to-date forecast and warning capabilities. The National Weather Service's recent $4.5 billion modernization is benefiting every American – at a cost of just $4 per person per year.

As I mentioned earlier, predictions are already faster and more accurate, and they are safeguarding lives and the economy. Data assimilation and collection needs are, in part, being addressed by NOAA Modeling Centers. These centers are developing or implementing the meteorological numerical models that shape forecasts. A telecommunications gateway links all weather service data and products to national and international customers.

Weather forecasting is also being significantly bolstered by a series of polar and geostationary satellites. With improved imaging and sounding capabilities, the NOAA-15 is the first in a series of five satellites designed to monitor global environmental events. The satellites will scan the Earth over the next 12 years, yielding continuous images of atmospheric temperatures, moisture, and aerosol distributions, and surface parameters such as snow and ice.

Combined with data from Doppler radars and automated surface observing systems, the real-time data gathered by geostationary satellites greatly aids weather forecasters in providing better warnings of thunderstorms, flash floods, hurricanes, and other severe weather.

An essential new system – the Advanced Hydrologic Prediction System – will significantly extend the Nation's ability to mitigate the impact of major floods and droughts. The economic benefits of this system will total about $600 million annually. Weather and climatic prediction models will provide new forecast products depicting the magnitude and probability of river levels and river flow volumes several months into the future.

NOAA is committed to developing mid- and long-range climate forecasts that can be issued weeks, months, and even years in advance. The most recent El Niño brought home the value of longer-range forecasts. By monitoring changes from the deep oceans to the surface of the sun, NOAA will be able to provide the basis for understanding longer-term climate and environmental patterns that, in some manner, impact all forms of surface transportation.

In looking to the future, we envision great advances in computer and communication technologies that will provide immense improvements in safety and efficiency, but also have increased vulnerability to weather conditions.

Tailored observations and reporting networks are needed all along transportation routes, and high-resolution models are needed to provide more accurate information to decision-makers.

While intelligent transportation systems are now being developed to address current needs, the demand on transportation is already outstripping the pace of development. And that demand is expected to triple in 25 years.

However, the best prediction and assessment tools won't count unless we can get urgent information into the hands of those who most need it – *and when they most need it*. We are creating a Global Disaster Information Network for just this purpose. The Network will take us beyond monitoring, assessment and prediction to the dissemination of information when and where it is needed.

The Internet and other high-speed telecommunications provide the necessary technologies – and a disaster information network will be assembled by tapping data and other information sources from around the globe.

In partnership with other public and private agencies, NOAA is committed to solidifying the existing foundation of weather information, products, and services. We recognize that there will be exceptional and accelerating demands on evolving transportation systems well into the next century – and we look forward to addressing these challenges right along with you.

Just as you, we want to keep natural hazards from becoming natural disasters.

Thank you.

PRESENTATIONS

Transportation Operations:

Dr. Christine Johnson, *Program Manager, Operations Core Business Unit, Department of Transportation, Federal Highway Administration*

Synopsis: Why now? The mission of the FHWA has shifted from the construction of the Interstate Highway System to one of operating the system. The economy demands a higher level of certainty in the operation of the highway system and new technologies provide the opportunity to improve the system. Margins of profitability require better use of weather and other transportation information to improve the capacity of the system and to make it more predictable and reliable. Communications and the information industry provide tools to better manage resources and the variables affecting the system to help optimize the system. Information must be tailored to decisions. This process includes filtering, fusion, and options review, with weather information providing probably the highest payoff.

Website: www.fhwa.dot.gov

ITS Architecture & Outcome Measures:

Mr. Bruce Eisenhart & Dr. Joseph Peters, *Department of Transportation-ITS-JPO*

Synopsis: The National ITS architecture provides the framework for a needs-based process leading to system requirements. Just as an architect plans lay out the design of a house, the National ITS Architecture provides a master blueprint for building an integrated, multi-modal, intelligent transportation system. It defines the framework around which a generally common ITS infrastructure can be developed, while ensuring that local needs are met. This framework will help state and local decision-makers plan smarter and buy smarter, ultimately, saving time and money in the future while making their regions more economically attractive. Dr. Peters described evaluation aspects of the transportation system. He noted that 17 percent of traffic fatalities were due to weather and that 60 percent of these occurred in rural areas. Dr. Peters also stated there is a need to develop a benefits/cost database for transportation systems.

Website: www.fhwa.dot.gov
Slides: *National ITS Architecture, Intelligent Transportation Systems: Evaluation and Assessment*, Appendix B, (See OFCM website www.ofcm.gov).

Weather-Related Transportation Accidents:

Dr. H. Keith Brewer, Director, *Office of Human Centered Research*, *National Highway Traffic Safety Administration*

Synopsis: Dr. Brewer noted that there is an average of 20 major pileups per year due to weather. During the period 1989-98, adverse weather caused 28 percent of the crashes, 25 percent of those injured, and 19 percent of the fatalities. The economic cost of accidents is $42 billion per year, which are about 30 percent of the overall cost of accidents.

Website: www.nhtsa.dot.gov
Slides: *Overview of U.S. Crashes & Weather Environment*, Appendix B, (See OFCM website www.ofcm.gov).

Transportation Weather-Related Issues:

Dr. Ronald McPherson, Executive Director, *American Meteorological Society*

Synopsis: Dr. McPherson focused his presentation on weather information issues and coordination and cooperation issues. Weather information issues include the credibility of weather advisories, hazardous versus non-hazardous adverse weather, information assimilation and communications, and the evaluation of weather information effectiveness (verification). Coordination and cooperation issues include those among communities of ITS, public and commercial concerns, and the weather providers and operational decision-makers.

Website: www.ametsoc.org/AMS/

PANEL SESSIONS

Departments of Commerce and Defense Weather Services and Capabilities for Surface Transportation Decision Support

Chair: Ms. Barbara Semedo, *Director*
Public and Constituent Affairs, National Oceanic and Atmospheric Administration

Synopsis

This panel consisted of Federal environmental support agencies chartered with providing weather products to a wide-range of customers with divergent needs. Regardless of the consumers, several fundamental core themes were shared: resolution, tailoring, coordination, standardization, decision-thresholds, and liabilities/believability.

- ♦ Increasing the temporal and spatial resolution. Are the customers' environmental decision thresholds being adequately addressed? Timeliness addresses several issues; e.g., time from creation of the environmental support product to the actual delivery to an end-customer and the amount of advance warning that can be expected given the model time and physics constraints. Atmospheric model runs are (as a rule) created every 12 hours with forecasts through 7-10 days. Development of atmospheric models from the coarser global scales to a more refined, granular mesoscale/local depiction is critical in resolving those weather elements pertinent to surface transportation.

- ♦ Developing tailored product suites with particular attention to visualization techniques, etc. Currently the full-spectrum weather support includes observations, forecasts, warnings, and climatology. The providers are charged with producing the necessary information support in an eye-catching, physically consistent, legitimate manner. Creation of tailored-decision aids (TDAs) that translate weather events into recommended action is the goal.

- ♦ Increasing the coordination between providers and users to create capability and technology transfer leverages. Coordination between Federal and private/public sectors creates an R&D culture that results in mutual and often free exchange of scientific discovery. The transition from basic research to operational application is being strengthened by this collaboration.

- ♦ Standardization. National and international standards are an absolute necessity. In this instance, environmental standards encompass creation, establishment, maintenance and archive of observations, model output, product output (message text, 2-D and 3-D animation), and terminology and graphics criterion. Communication standards, i.e., protocols, packet compression, compression algorithms, transmission and reception speeds, to name a few, compound the complexity of data/product delivery.

- Clientele defined "thresholds" for environmental support initiation. Several weather forecasts and events trigger subsequent action and reaction by the transportation community.

    - Temperature. Pavement temperature is critical in determining the use of the appropriate chemical to disrupt the development of ice or melt snow. Sub-surface temperature is relevant for roadway thaws and freezes. Temperature, coupled with wind speed, determines exposure limitations.

    - Hydrometeors. Any type of liquid precipitation given the right circumstances, i.e., accumulation, rate, intensity, etc. especially freezing precipitation.

    - Wind-direction and speed. Wind direction and speed are factors in vehicle stability, drifting snow, blowing dust, and sand.

    - Severe weather events-thunderstorms, tornadoes, hurricanes.

    - Black ice accretion.

    - Visibility-Reductions caused by hydrometeors or lithometeors.

  These environmental "triggers" are extremely location and event (time and rate) driven; e.g., snow accumulation in excess of four inches over two days may cause transportation woes in the metropolitan and urban south, but the same event may not be a safe transportation factor in the northern tier states.

- Liabilities/Believability. In order to engender trust, credibility is the product litmus test. Credibility is generated by creating an historical track record of accurate and timely forecasts. Only then, does product liability become a non-issue. To that end, environmental product quality control, training and certification standards are paramount.

Panel Membership:

Mr. Greg Mandt, *Department of Commerce, National Weather Service*
Website/email: Greg.Mandt@noaa.gov
Slides: *Weather Information Support to Surface Transportation*, Appendix B (See OFCM website www.ofcm.gov).

Col. Michael Neyland, *Department of Defense, Air Force*
Website/email: neylandm@pentagon.af.mil
Slides: *Weather Support for America's War Fighter*, Appendix B, (See OFCM website www.ofcm.gov).

CAPT Barry Donovan, *Department of Defense, Navy*
Website/email: donovan.barry@hq.navy.mil
Slides: *Naval Meteorology and Oceanography (METOC)*, Appendix B, (See OFCM website www.ofcm.gov).

Dr. William Hooke, *Department of Commerce, United States Weather Research Program*
Website/email: William.Hooke@noaa.gov

Commercial Weather Information Production Capabilities and Services

Chair: Ms. Julie Campbell, *President*
The Campbell Marketing Group, Inc.

Synopsis

Issues and Perspectives

1. Panel achieved the objective of expanding the awareness of the private sector capabilities and roles in providing weather products, services, and capabilities. Panel members identified new products address surface transportation needs, especially in the context of where the private sector can support the public sector and the specialized needs of transportation users.

2. The private and public roles in the dissemination of information was explored:
   - NWS addressing data format issues
   - Synchronicity among the media--simple, consistent, concise and clear messages transmitted to public and how much is too much information

3. The nature of the media "business of weather information" and the media constraints:
   - ability to deploy meso-nets of data
   - ability to invest in products
   - reliance on the private sector value-added companies to develop products specifically for use by the media
   - reliance on the NWS for data and responsibility to disseminate warnings accurately
   - the nature of a self-assessment on performance during severe weather coverage

4. Market research impacts on:
   - product development
   - emphasis on coverage
   - opportunities and constraints of the Internet as a delivery mechanism
   - trends defining product and service delivery
   - lifestyle demands driving product and service delivery
   - sophistication levels of each audience

5. "Official" versus emerging observing systems
   - needs for more meso-net type systems
   - diversity in sources of deployment--state, local, private
   - standardization of observations, data formats, etc.
   - integrating the non-weather systems into "information", such as the traffic cameras for weather news segments
   - standardization of dissemination and "ownership" or proprietary data sources

Panel Membership:
Mr. Chuck Herring, *The Weather Channel*
Website/email: www.weather.com

Mr. Andrew Humphrey, *FOX-TV5*
Website/email: www.fox5dc.com (under construction)
Slides: *Symposium on Weather Information for Surface Transportation*, Appendix B, (See OFCM website www.ofcm.gov).

Ms. Maria Pirone, *WSI*
Website/email: mapirone@wsicorp.com
Slides: *Current & Future Capabilities of the Commercial Weather Services Association (CWSA)*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. J. Michael Connelly, *Alden Electronics, Inc.*
Website/email: jmc@alden.com

Mr. Dave Jones, *NBC-TV4*
Website/email: wxnet4.nbc4.com/wnet4/home.cfm
Slides: *Commercial Weather Information Production Capabilities and Services*, Appendix B, (See OFCM website www.ofcm.gov).

Federal Agency Weather Information Needs

Chair: Mr. James Washington, *Director*
Air Traffic System Requirements Service, Department of Transportation-Federal Highway Administration

Synopsis

This panel consisted of Federal agencies whose mission charter consists of providing transportation services (advocacy and liaison) with emphasis on safety of operation. These agencies are dependent on other providers for weather information but are subsequently responsible for providing decision support to their consumers. There were several common surface transportation recurring themes, specifically, users/providers information exchange, research and development (R&D), standards, timely and accurate environmental information, and tailored-decision aids.

- Users/providers information exchange. Users need to know what product suites are available and their limitations to formalize an operations plan. Also, users need to provide specific environmental thresholds (weather element factors) to the weather support provider so tailored product groups can be created.

- Research and development. FHWA conducts R&D in conjunction with state Department of Transportation (DOT). Also, FHWA has begun a review process to identify user requirements to be addressed by the environmental support providers.

- Standards. Development of the Road Weather Information System (RWIS) and commercial environmental information systems are not readily integrated into a national database. This information, some proprietary, needs to adhere to national and international observation and data dissemination standards.

- Timely and accurate environmental information. Inherent in all decision-making is the timely processing of critical information. When weather affects surface transportation, the ability to respond is determined by having the right forecast or observation at the critical moment in the decision process. Weather providers need to create weather products that provide this information in a manner consistent with the needs of the end user. The end user desires finer resolution (neighborhood vice city), accuracy (freezing rain vice snow), and timely (minutes vice hours) forecasts.

- Tailored-decision aids. TDAs need to be based on specific user requirements. R&D efforts have identified several weather elements that play a role in surface transportation, i.e.,

  - Temperature.

  - Precipitation, especially freezing precipitation.

  - Wind-wind speed and direction.

  - Severe weather events-thunderstorms, tornadoes, hurricanes.

  - Visibility.

Mr. Paul Pisano, *Department of Transportation, Transportation Operations*
Website/email: Paul.Pisano@fhwa.dot.gov
Slides: *Federal Agency Weather Information Needs and Requirement, Federal Highway Administration*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Michael Rossetti, *Department of Transportation, FRA*
Website/email: Rossetti@volpe.dot.gov
Slides: *Weather Issues and Needs for Railroads*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Arthur Handman, *Department of Transportation, FTA*
Website/email: ghtd@compuserve.com
Slides: *Transit Weather Information Requirements*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Michael Keane, *Department of Energy, NTP*
Website/email: Micheal.Keane@em.doe.gov
Slides: *Weather Information for Surface Transportation*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. John Gambel, *FEMA*
Website/email: john.gambel@fema.gov

Mr. Patrick Mendonca, *U.S. Postal Service*
Website/email: pmendonc@email.usps.gov

Mr. Robert Anderson, *USDA-FSA-KCC*
Website/email: randerson@kcc.fsa.usda.gov

State and Urban/Rural Transit Weather Information Needs

Chair: Mr. Kenneth Kobetsky
American Association of State Highway and Transportation Officials

Synopsis

This panel consisted of state and local transit agencies whose mission statement is to move people and commodities consistently, economically and safely. The application is complex. These authorities are weather customers who must provide responsible decision support to their constituents and respond during weather-related emergencies. Some common surface transportation issues that were discussed: customer-defined decision thresholds, accuracy and timeliness of environmental support information, support providers and proprietary information, data exchange standardization (between public and private agencies and neighboring states), information dissemination mechanisms, development of plans and procedures, and assignment of specific roles (accountability and responsibility).

- Customer defined decision thresholds. Weather forecasts and observations trigger action and often reaction by transportation agencies.

    - Temperature. Extremes and changeover times are critical in determining the use of appropriate agents to prevent the development of ice or aid in snow depletion.

    - Precipitation. Any type of precipitation given the right circumstances, i.e., accumulation, rate, intensity, etc. especially freezing precipitation.

  These thresholds are extremely location and event (time and rate) driven.

- Accuracy and timeliness of environmental support information. Surface transportation needs require the best information possible in a timely manner. In addition, rapid refreshment rate is critical. When conditions change, are updates created rapidly and are the thresholds that would cause an update clearly defined?

- Support providers, proprietary information, data exchange standardization, and information dissemination mechanisms. Private and public sector vendors have generated new support applications and functions. These systems are playing an important role in the support structure for local and state officials. Concerns are rising over the ownership of the networked weather data and the ability to share this data with neighboring states and federal agencies without violating proprietary ownership.

Once the issue of ownership accountability is resolved, data and communications standards and reliability issues must be addressed before inclusion into a national/international network. Who sets the data exchange formats and standards? Most vendors have developed efficient network or Internet protocol data exchange routines but this data and mechanisms are exclusionary and do not address the World Meteorological Organization (WMO) or national standards. This is a critical data mining issue.

- Development of plans, procedures and assignment of specific roles. Coordination, prior planning, clearer definition of assigned responsibilities and designations of authority are events that must be exercised prior to a weather catastrophe. During the 1999 hurricane season, the largest non-war related evacuation took place due to Hurricane Floyd. Federal, state and local officials were overwhelmed by the magnitude of the task. Although some disaster evacuation plans had been commissioned years earlier, the application of those plans uncovered numerous inadequacies--lack of training, no rehearsal plan, incomplete coordination, strategy refreshment, and incomplete delegation of authority. The resolution of these issues at all levels of surface transportation must become a priority.

Panel Membership:

Mr. Robert Stowe, *Washington State, Department of Transportation*
Website/email: stoweb@wsdot.wa.gov

Mr. Michael Adams, *Wisconsin State, Department of Transportation*
Website/email: michael.adams@dot.state.wi.us
Slides: *The Wisconsin Road Weather Information System (RWIS)*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Manny Agah, *Arizona State, Department of Transportation*
Website/email: magah@dot.state.az.us

Mr. Michael Simonetti, *New York City Transit*
Website/email: msimon3@nyct.com

Mr. Mark Gibson, *DC Metropolitan Transit*
Website/email: mgibson@WMATA.com

Mr. Howard Chapman, *Charleston, SC Transit*
Website/email: chapmanh@ci.charleston.sc.us.

Professional and Trade Organization Weather Information Needs

Chair: Mr. Kevin Hiett
American Automobile Association

Synopsis

This panel consisted of professional and trade organizations whose motivations share an economic component. Their environmental concerns are fundamental and highlight the conundrum faced by support providers and the professional trade decision-makers, namely, the goal of delivering goods--profitably and on-time. Certain weather-related losses are anticipated; but until those losses exceed an accepted loss-to-profit ratio, the trade organizations are not heralds of weather marketing change. However, each organization works at minimizing their "anticipated weather losses" by identifying those environmental parameters that affect their operations and pursuing those support agencies that can provide analyses and forecasts to mitigate the likely loss of operational assets.

- Environmental parameters.
    - Wind-direction and speed.
    - Temperature extremes.
    - Precipitation. Any type of liquid precipitation given the right circumstances, i.e., accumulation, rate, intensity, etc. especially freezing precipitation.
    - Visibility.

A summation credo…

> *"Our customers demand consistent, reliable, dependable service at a reasonable cost—weather is no excuse!"*

Panel Membership:

Mr. Al Morin, *American Association of Railroads*
Website/email: allen.morin@bnsf.com

Mr. Kenneth Enzor, *National Association of Railroad Shippers*
Website/email: ken enzor/PROC/PSNA

Ms. Barbara McMahon, *American Association of Port Authorities*
Website/email: N/A

CAPT Chuck Pillsbury, *Maritime Institute of Technologies and Graduate Studies*
Website/email: mitagscp@bcpl.net

Mr. Paul Borghesani, *Manufactured Housing Institute*
Website/email: pdbord@ibm.net

Mr. Terry Priest, *Coors Brewing Company*
Website/email: www.coorsinvestor.com

Research/Technology Innovation and Decision Support

Chair: Dr. A.E. (Sandy) MacDonald
National Oceanic and Atmospheric Administration
Office of Atmospheric Research, Forecast Systems Laboratory

Subpanel 1

Key Results

The successes of commercial R&D transition to surface transportation support applications validates the need, e.g., FORETELL, ATWIS, IRRIS. Utilities typical of these applications are:

- ♦ Communications via the Internet, cell phone or shareware networking software.
- ♦ A mesoscale, fine resolution atmospheric model is utilized for the weather forecast.
- ♦ Support information consists of road conditions, roadway observations, highway and railway infrastructure data, i.e., construction, roadway status and environmental information.

New technologies are being developed by monitoring current surface transportation practices; e.g., message signs, rural traffic management centers and thermal mapping. Testbeds for these technologies include Interstate-90 and Interstate-99.

Panel Membership:

Dr. Dean Deeter, *Castle Rock Consultants*
Website/email: deeter@crc-corp.com
Slides: *FORETELL Integrating Intelligent Transportation Systems With Advanced Weather Prediction*, Appendix B, (See OFCM website www.ofcm.gov).

Prof. Leon Osborne, *University of North Dakota*
Website/email: leono@rwic.und.edu
Slides: *The Advanced Transportation Weather Information System*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Paul Allred, *Military Transportation Management Command*
Website/email: allredp@tea-emhl.army.mil
Slides: *Intelligent Road/Rail Information System, Highways & Railroads for National Defense*, Appendix B, (See OFCM website www.ofcm.gov).

Dr. Paul Jovanis, *Pennsylvania State University*
Website/email: ppj2@psu.edu
Slides: *I-99 Advanced Transportation Technology Test Bed*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Edward Adams, *Montana State University*
Website/email: eda@ce.montana.edu

Research/Technology Innovation and Decision Support

Subpanel 2

Key Results

As new technologies, heretofore unrelated to surface transportation, evolve, they can be applied to solve some of the problems associated with surface transportation, specifically, communication. Digital audio broadcasting utilizing the current AM/FM bands may one day replace broadband emergency warning systems. In the near future, vehicles could be notified of hazards automatically if the appropriate equipment, such as GPS receivers and transponders, become standard equipment. One day, we could be sheltered by our own transportation flight plan similar to today's aviation flight plan.

R&D efforts, particularly NEXRAD R&D, will have a direct application to the Intelligent Transportation System (ITS). Travelers will routinely receive, in real-time, a display of severe weather.

Technology transfer from R&D takes too long to implement operationally. The process needs to be revamped to utilize cutting-edge technology. The National Innovation Process is an approach that compresses and reduces the implementation times for creative technology, thus, placing applications in the hands of the operator before the technology needs to be refreshed.

Panel Membership:

Mr. Scott Stull, *USA Digital Radio*
Website/email: stull@usadr.com
Slides: *The Digital AM & FM Experience*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Dwight Taylor, *Digital Radio Express*
Website/email: N/A.

Mr. Michael Eilts, *National Severe Storms Laboratory*
Website/email: eilts@nstl.noaa.gov
Slides: *Applications for the Intelligent Transportation System*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Richard Wagoner, *National Center for Atmospheric Research*
Website/email: wagoner@ucar.edu
Slides: *The Role of Advanced Signal Detection Techniques in the Development of High-resolution, Accurate Decision Support Systems*, Appendix B, (See OFCM website www.ofcm.gov).

Mr. Fenton Carey, *Department of Transportation, RSPA*
Website/email: http://www.rspa.dot.gov/

User Focus Group #1:

State Weather Information Needs

Weather Information for Surface Transportation

Breakout Session 1

State Weather Information Needs

Session 1 - Leadership

Co-Chairs:
Mr. Michael Adams, ***Wisconsin DOT***
Dr. Wilfred Nixon, ***Univ of Iowa***

Rapporteurs:
Ms. Cynthia Nelson, ***OFCM***
Mr. Gary Nelson, ***FHWA-Mitretek***

Session 1 - Key Results

- Trigger Events
  - Temperature within +/- 1 m of surface
  - Precipitation: snow, rain, ice storms
  - Wind: drifting, vehicle stability, visibility
  - Black ice
  - Visibility: fog, blowing dust, snow
- Specifics/details
  - Wide range of users, locations, sophistication
  - Continuous/area versus point forecast
  - Need to assess ranges of values

Session 1 - Key Results(2)

- Standards/Formats
  - Standardization important--coordinated by federal agencies
  - Standardization for both input and output--data and displays
  - Standard warning criteria across geopolitical boundaries
  - Data gathering and collections - public, open, free

E.g., GIS, ITS, weather data formats, common communication formats.

Session 1 - Key Results(3)

- Other
  - Liability and believability
  - More observations, finer resolution (water, land; buoys, pavement sensors, mobile, etc.)
  - Training and certification for users
  - Post storm verification
  - Cost-benefit analysis
  - Shared infrastructure
  - Fusion of traffic and weather information
  - Operational coordination of maintenance and management
  - Technology transfer

User Focus Group #2:

Local Rural/Urban (Metro Traffic and Transit) Weather Information Needs

Weather Information for Surface Transportation

Breakout Session 2

Local Rural/Urban (Metro Traffic and Transit) Weather Information Needs

Session 2 - Leadership

Co-Chairs: **Mr. Douglas Jonas,** ***Matrix Management Group***

Mr. Edward Boselly, ***Weather Solutions, Inc.***

Rapporteurs: **Mr. James Harrison,** ***OFCM***

Mr. Floyd Hauth, ***STC***

Session 2 - Key Results

- Lead time is important consideration; amount of lead time varies with application and operational environment
- There appears to be a need to understand the utility of tailored forecasts in lieu of multiple sources of non-specific weather information
- The observation network is insufficient to meet the needs of the surface transportation community

Session 2 - Key Results(2)

- There is a need for forecast of small-scale features to describe highly localized conditions such as fog
- The placement of decision making is different among the various modes of transportation, and requires recognition by weather information providers
- Forecasts of <u>good</u> weather are also valuable to the decision makers

User Focus Group #3:

Professional and Trade Organizations Weather Information Needs

Weather Information for Surface Transportation

Breakout Session 3

Professional Associations and Trade Organizations Weather Information Needs

Session 3 - Leadership

Chair: **Mr. Kevin Hiett, *AAA***

Rapporteurs: **Mr. Thomas Piwowar, *STC***
Mr. Thomas Fraim, *OFCM*

Session 3 - Key Results

- Need NWS product catalog
- Need weather information product education and training for operators - leads to credibility
- Place list of requirements factors on web site - as interim measure
- Keep requirements questionnaire on web site
- Recognize that requirements process is iterative

Session 3 - Key Results

List of Requirements Factors

- Needs/Requirements: Need to be identified and refined
- Comprehensive/Breadth - focus on <u>major</u> requirements
- Recognize geographic location dependence
- Keep in mind the vehicle type/infrastructure object of interest
- Independence of implementation
- Decision criteria
  - Define thresholds: fixed and varying
  - Relevance

Session 3 - Key Results

List of Requirements Factors (cont'd)

- Lead time and updates (real time)
- Accuracy and credibility
- Accessibility
  - Readability
  - Dissemination
  - Availability
  - Reliability

SYMPOSIUM GOALS AND ACTION PLAN/NEXT STEPS

The goal of the symposium was to establish the national needs and requirements for weather information associated with decision-making actions involving surface transportation. This goal is consistent with a major theme of the historic Transportation Equity Act for the 21st Century. Secretary of Transportation Rodney E. Slater, in his summary message describing this important legislation, stated that *"...transportation is about more than concrete, asphalt, and steel: it is about people, and about providing them with the opportunity to lead safer, healthier, and more fulfilling lives."* Implicit in Secretary Slater's statement are the effects that weather can have on the safety, health and productivity of our Nation's citizens whether they are in the public or private/commercial sector. Action includes the expansion of coordinated support in response to national needs and requirements identified here.

- Highlight the environmental aspects of the Transportation Equity Act for the 21st Century (TEA-21);
- Explore current weather issues impacting surface transportation;
- Explore the impacts of weather on surface transportation safety;
- Explore how weather information needs are being met today;
- Explore the value of forecasts and other weather information for decision support;
- Explore technology alternatives to enhance surface transportation decision support;
- Explore how research and technology can provide a national transportation weather information system;
- Explore ways to address weather information for decision support;
- Build a clear understanding of needs by establishing:
    - an open and honest dialog between the user community and the weather providers;
    - a data rich WIST questionnaire;
    - coherent symposium proceedings; and
    - a requirements document by Summer 2000;

- Strengthen or build new alliances and partnerships among all entities represented;

    - Complemented by FHWA short-term focus on winter road maintenance;

- Continue exploration of relevant requirements using the Joint Action Group for Weather Information for Surface Transportation;

- Move beyond the obvious and consider previously little explored areas, such as air quality, mirages, sun glint, space weather effects on navigation, communication, and pipeline electrical currents, etc;

- Assess the recommendations from each panel and breakout session;

- Publish proceedings in February 2000;

- Distribute draft requirements document for review in May/June 2000;

- Requirements document published during Summer 2000;

- Forum in Fall 2000; and

- Continue iterative development of requirements.

PROGRAM

Symposium on

Weather Information for Surface Transportation:

Delivering Improved Safety and Efficiency for Tomorrow

November 30 - December 2, 1999

HOLIDAY INN
SILVER SPRING, MARYLAND

Transportation Planning and Operations
Intelligent Transportation Systems
Weather Information Capabilities
Weather Information Research

OFCM

Acknowledgements

The sponsors of the Symposium on Weather Information for Surface Transportation, the Office of the Federal Coordinator for Meteorological Services and Supporting Research and the U.S. Department of Transportation - Federal Highway Administration, wish to thank all those individuals and agencies attending and participating in this forum. In particular, we gratefully appreciate those individuals and agency representatives who are participants on the panels and in the breakout sessions.

Finally, we specifically acknowledge Professor Leon Osborne, University of North Dakota, who graciously permitted the use of the photograph on the cover of this program.

Table of Contents

MEMBERS
JOINT ACTION GROUP
FOR WEATHER INFORMATION
FOR SURFACE TRANSPORTATION

OFCM	-	Mr. Blaine Tsugawa, OFCM
DOC	-	Mr. Michael Tomlinson, NOAA/NWS
DOD	-	Col Larry Freeman, USAF, Deputy to NOAA
	-	Lt Col Gerald Borger, USAF, USTRANSCOM
DOE	-	Mr. Rickey Petty, ESD
	-	Mr. Tony Thomas, T&EM
DOI	-	Mr. Lewis Moore, USBR
DOT	-	Mr. Paul Pisano, FHWA
	-	Mr. Donald Plotkin, FRA
	-	Mr. William Wiggins, FTA
	-	Mr. Michael Rossetti, RSPA/Volpe Center
	-	Dr. Jonathan Berkson, USCG
EPA	-	Mr. William Russo
FEMA	-	Mr. John Gambel
NASA	-	Dr. Ramesh Kakar
NRC	-	Ms. Leta Brown
NTSB	-	Mr. Donald Eick
USDA	-	Mr. Bradley Rippey
USPS	-	Ms. Faye Arvonio

ABOUT THE SYMPOSIUM

The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) and the U.S. Department of Transportation – Federal Highway Administration (USDOT-FHWA) are co-sponsoring this symposium.

The goal of the symposium is to establish the national needs and requirements for weather information associated with decision-making actions involving surface transportation. This goal is consistent with a major theme of the historic Transportation Equity Act for the 21st Century. Secretary of Transportation Rodney E. Slater, in his summary message describing this important legislation, states that "… *transportation is about more than concrete, asphalt, and steel: it is about people and about providing them with the opportunity to lead safer, healthier, and more fulfilling lives*." Implicit in Secretary Slater's statement are the effects that weather can have on the safety, health, and productivity of our Nation's citizens regardless of whether they are from the public or private/commercial sector.

We are setting a precedent with this effort of establishing national needs and requirements for weather information for surface transportation. To our knowledge, no such comparable effort has been undertaken previously.

Briefings and panel discussions are intended to assist the participants in understanding the overall, relevant weather information issues and needs for surface transportation decision-making activities. Breakout sessions will focus on specific user group issues and needs.

A short questionnaire has been developed to capture the wide-range of needs and requirements for weather information expected from our Nation's surface transportation constituents. Completed questionnaires will be collected at the conclusion of the breakout sessions scheduled for the afternoon of December 1st.

The Honorable Dr. Stephen D. Van Beek
Associate Deputy Secretary of Transportation

Stephen D. Van Beek joined the Research and Special Programs Administration (RSPA) in February 1998. As Deputy Administrator, he is a member of the Secretary's Management Council (SMC), where he has taken a special interest in facilitating DOT efforts at strengthening ties with Minority Serving Institutions, including colleges and universities; leading DOT efforts at establishing a quality award process, and; championing a management development process for the future DOT.

At RSPA, Dr. Van Beek serves as Chief Operating Officer and has played key roles in shaping RSPA's new strategic plan, research and technology strategies, emergency preparedness and response activities, and new regulations for the pipeline and hazardous materials safety programs. In addition, he has led RSPA efforts on responding to the Y2K issue.

Dr. Van Beek is on leave from San Jose State University (SJSU) in California, where he is Associate Professor of Political Science. At SJSU, he has taught a variety of courses in American politics and public policy and has published Post-Passage Politics: Bicameral Resolution in Congress (University of Pittsburgh Press, 1995) and several other works on the presidency, public ethics, transportation, foreign legislatures and elections.

While at SJSU, he was also a research associate with the Norman Y. Mineta International Institute of Surface Transportation Policy Studies, where he participated in studies on labor-management relations, transit policy, and transportation education. Dr. Van Beek has also taught at Washington and Lee University and served as a legislative assistant to former California Representative Tony Coelho.

Dr. Van Beek received his doctorate and masters in government and foreign affairs from the University of Virginia. He received his bachelors of Arts degree from the University of California, Santa Barbara. He is a member of Phi Kappa Phi, a national honor society, and several professional organizations.

The Honorable D. James Baker
Undersecretary of Commerce
for Oceans and Atmosphere

Dr. D. James Baker is Administrator of the National Oceanic and Atmospheric Administration (NOAA) and Under Secretary for Oceans and Atmosphere at the U.S. Department of Commerce. In this position, he is responsible for the National Weather Service; the National Environmental Satellite, Data, and Information Service; the National Marine Fisheries Service; the National Ocean Service; and NOAA's Office of Oceanic and Atmospheric Research. He serves as the U.S. Commissioner to the International Whaling Commission.

He also serves as a Co-Chair of the Committee on Environment and Natural Resources of the National Science and Technology Council and as an ex-officio member of the President's Council on Sustainable Development. He is Co-Chair of the Environmental Working Group and Vice Chair of the Space Committee of the U.S. Russian Joint Commission on Economic and Technological Cooperation; and Vice Chair of the Science and Technology Committee of the U.S. South Africa Bi-national Commission. He served as Chair of Coastal America from 1992 to early 1995 and as Acting Chair of the Council on Environmental Quality from November 1993 to February 1994.

He previously served as President of the Joint Oceanographic Institutions, Incorporated; as Dean of the College of Ocean and Fishery Sciences at the University of Washington; as a Group Leader for Deep-Sea Physics at NOAA's Pacific Marine Environmental Laboratory; as an Associate Professor at Harvard University; and as a Research Associate at the University of Rhode Island.

Dr. Baker is the author of the book, ***Planet Earth-The View from Space***, published by Harvard University Press in 1990, and has written extensively on climate, oceanography, and space technology issues. He is a fellow of the American Meteorological Society and of the American Association for the Advancement of Science. Dr. Baker has served on numerous advisory committees for the Administration, the National Academy of Sciences, and various international bodies.

Symposium on
Weather Information for Surface Transportation

AGENDA

Tuesday, November 30, 1999

7:00-8:30 AM	**Registration and Continental Breakfast**
8:30 AM	**Introduction/Overview** Mr. Samuel Williamson *Office of the Federal Coordinator for Meteorology*
9:00 AM	**Keynote Addresses**: The Honorable Dr. Stephen D. Van Beek *Deputy Secretary of Transportation*
9:30 AM	The Honorable D. James Baker, *Undersecretary of Commerce for Oceans & Atmosphere*
10:00 AM	**Transportation Operations**: Dr. Christine Johnson *Department of Transportation, Federal Highway Administration*
10:30-11:00 AM	***BREAK***
11:00 AM	**ITS Architecture & Outcome Measures**: Mr. Bruce Eisenhart and Dr. Joseph Peters *Department of Transportation-ITS-JPO*
11:30	**Weather-Related Transportation Accidents**: Dr. H. Keith Brewer *National Highway Transportation SafetyAdmin.*
12:00-1:30 PM	***WORKING LUNCH*** - Provided
1:30 PM	**Transportation Weather-Related Issues**: Dr. Ronald McPherson, Executive Director *American Meteorological Society*
2:00-3:15 PM	**Panel 1** : DOC and DOD Weather Services and Capabilities for Surface Transportation Decisions Support

Chair:	Ms. Barbara Semedo, *National Oceanic and Atmospheric Administration - Public and Consultant Affairs*
Rapporteur*:*	Ms. Cynthia Nelson, OFCM
Panelist:	Greg Mandt, DOC-NWS Col M. Neyland, DOD-*Air Force* CAPT B. Donovan, DOD-*Navy* Dr. W. Hooke, NOAA-USWRP

<u>Tuesday, November 30, 1999</u> (*Continued*)

3:15 PM	***BREAK***		
3:30 -5:00 PM	**Panel 2**: Commercial Weather Information Production Capabilities and Services		
	Chair:	Ms. Julie Campbell, *The Campbell Marketing Group, Inc.*	
	Rapporteur:	Mr. Michael Tomlinson, NWS	
	Panelist:	Mr. Chuck Herring, Weather Channel Mr. Andrew Humphrey, FOX-TV5 Ms. Maria Pirone, WSI Mr. Michael Connelly, Alden Electronics, Inc. Mr. Dave Jones, NBC-TV4	
5:00 PM	***END OF DAY***		
5:30-7:00	***ICE BREAKER***		

<u>Wednesday, December 1, 1999</u>

7:00-7:45 AM	**Registration and Continental Breakfast**	
7:45-9:30 AM	**Panel 3**: Federal Agency Weather Information Needs	
	Chair:	Mr. James Washington, *Department of Transportation-Federal Aviation Administration*
	Rapporteur:	LtCol. G. Borger, DOD-TRANSCOM
	Panelist:	Mr. Paul Pisano, DOT-FHWA Mr. Michael Rossetti, DOT-FRA Mr. Arthur Handman, DOT-FTA Mr. Michael Keane, DOE-NTP Mr. John Gambel, FEMA Mr. Patrick Mendonca, U.S. Postal Service Mr. Robert Andersen, USAD-FSA-KCC
9:30-10:30 AM	**Panel 4**: State and Local (Counties/Cities) Weather Information Needs	
	Chair:	Mr. Kenneth Kobetsky, *American Association of State Highway and Transportation Officials*
	Rapporteur:	Mr. Doc Carver, OFCM-FAA
	Panelist:	Mr. Robert Stowe, Washington State Mr. Michael Adams, Wisconsin State Mr. Manny Agah, Arizona State Mr. Michael Simonetti, New York City Mr. Mark Gibson, DC Metropolitan Transit Mr. Howard Chapman, Charleston, SC Transit

Wednesday, December 1, 1999 (Continued)

10:30 AM	***BREAK***	
11:00AM-12:00 PM	**Panel 5**: Professional and Trade Organizations Weather Information Needs	
	Chair:	Dr. Mark Edwards, *American Automobile Association*
	Rapporteur:	Mr. Bradley Rippey, USDA
	Panelist:	Mr. Al Morin, Am. Assoc. of Railroads Mr. Kenneth Enzor, Natl. Assoc. of Railroad Shippers Mr. Martin Whitmer, Am. Road and Transp. Builders Assn. Ms. Barbara McMahon, Am. Assoc. of Port Authorities CAPT Chuck Pillsbury, MITGS Mr. Paul Borghesani, MHI
12:00 PM	***WORKING LUNCH*** - Provided	
1:30-3:00 PM	**Breakout Sessions** - User Focus Groups	

(1) State Weather Information Needs

(2) Local Rural/Urban Weather Information Needs

(3) Professional and Trade Organization Weather Information Needs

User Focus Group #1: State Weather Information Needs

Co-Chairs:	Dr. Wilfred Nixon, Univ. of Iowa Mr. Michael Adams, Wisconsin DOT
Rapporteurs:	Ms. Cynthia Nelson, NOAA-OFCM Mr. Gary Nelson, DOT-FHWA/MITRETEK Mr. Floyd Hauth, STC

User Focus Group #2: Local Rural/Urban (Metro Traffic and Transit) Weather Information Needs

Co-Chairs:	Mr. Douglas Jonas, Matrix Management Group Mr. Edward Boselly, Weather Solutions, Inc.
Rapporteurs:	Mr. James Harrison, NOAA-OFCM Mr. Michael Tomlinson, NOAA-NWS

User Focus Group #3: Professional and Trade Organizations Weather Information Needs

Chair:	Mr. Kevin Hiett, AAA
Rapporteurs:	Mr. Thomas Piwowar, STC Mr. Thomas Fraim, NOAA-OFCM Mr. Donald Eick, NTSB

<u>Wednesday, December 1, 1999</u> (*Continued*)

3:15 PM	***BREAK***
3:30-5:00 PM	**Breakout Sessions** (Continued)
5:00 PM	***END OF DAY***
5:30-7:00	***MIXER***

<u>Thursday, December 2, 1999</u>

7:00-8:00 AM **Continental Breakfast**

8:00 AM **Recap of Days 1 and 2**
- Panels 1, 2, 3, 4 and 5
- Breakout Sessions 1, 2 and 3

9:00 AM **Panel 6**: Research/Technology Innovation and Decision Support

Chair: Dr. A.E. (Sandy) MacDonald, *National Oceanic and Atmospheric Administration-Forecast Systems Laboratory*

Rapporteur: Col L. Freeman, DOD
Mr. Thomas Fraim, OFCM

<u>Subpanel 1</u>
***Panelist*s**
Dr. Dean Deeter, Castle Rock Services
Prof. Leon Osborne, Univ. North Dakota
Mr. Chris Barrett, DOE-TRANSIMS
Mr. Paul Allred, Military Transportation Command
Dr. Paul Jovanis, Penn State Univ.
Mr. Edward Adams, *Montana State Univ.*

<u>Subpanel 2</u>
***Panelist*s**
Mr. Scott Stull, USA Digital Radio
Mr. Dwight Taylor, Digital Radio Express
Mr. Edward Adams, Montana State Univ.
Mr. Michael Eilts, Natl. Severe Storms Laboratory
Mr. Richard Wagoner, NCAR
Mr. Fenton Carey, DOT-RSPA

10:30 AM	***BREAK***
11:00 AM	**Panel 6**: Research/Technology Innovation and Decision Support (Continued)
12:00 PM	***WORKING LUNCH*** - Provided
1:30 PM	**Action Plan/Next Steps**
2:30 PM	***ADJOURNMENT***

National ITS Architecture

Symposium on Weather Information for Surface Transportation

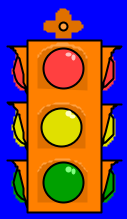
November 30, 1999

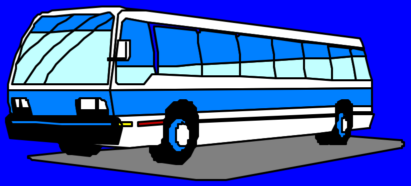
Bruce Eisenhart
Lockheed Martin

Architecture Development Team

What is an architecture?

- Identifies participants
- Defines boundaries
- Describes activities or functions
- Helps develop blueprint for effective cooperation

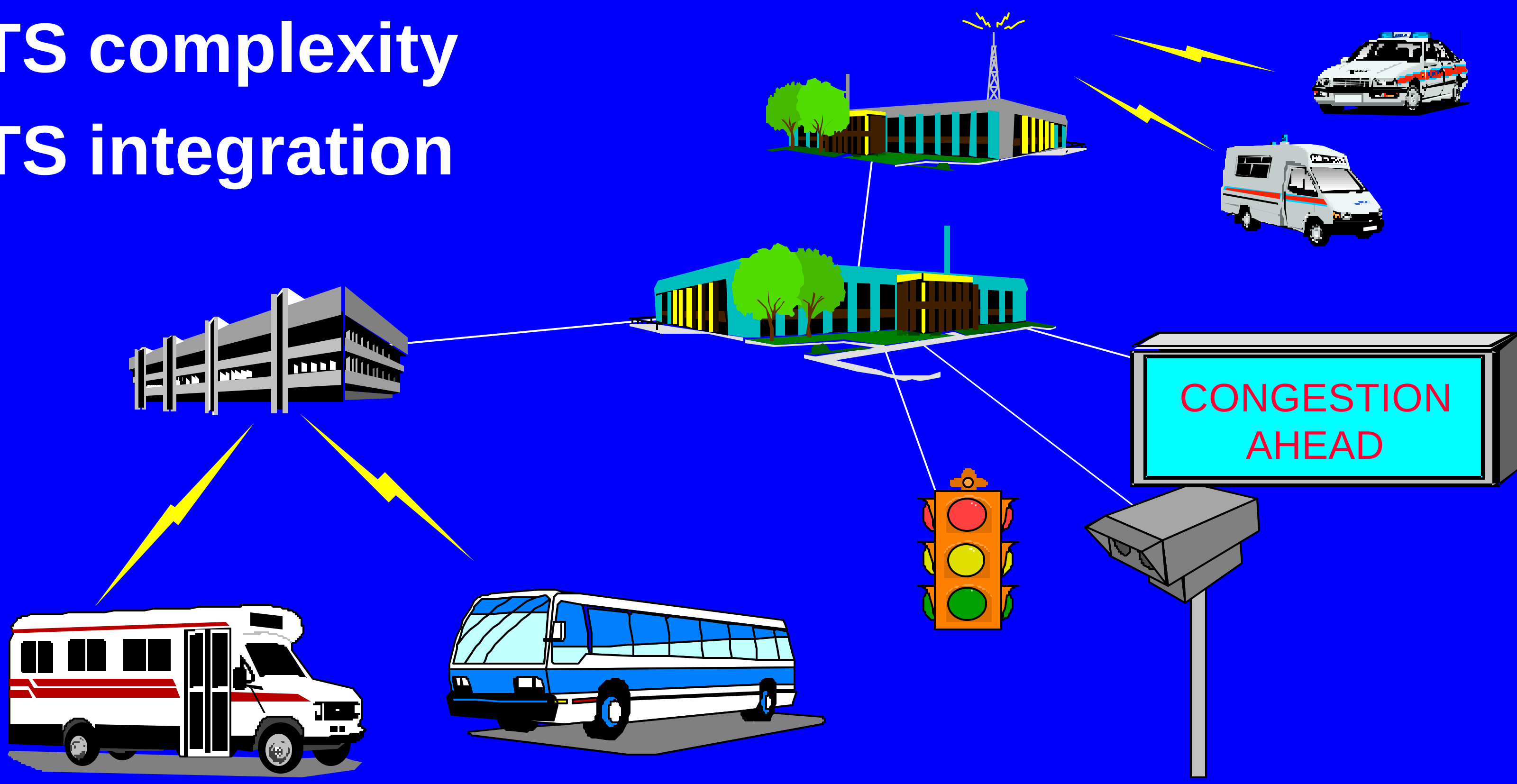




Architecture Development Team

Why was the National ITS Architecture Developed?

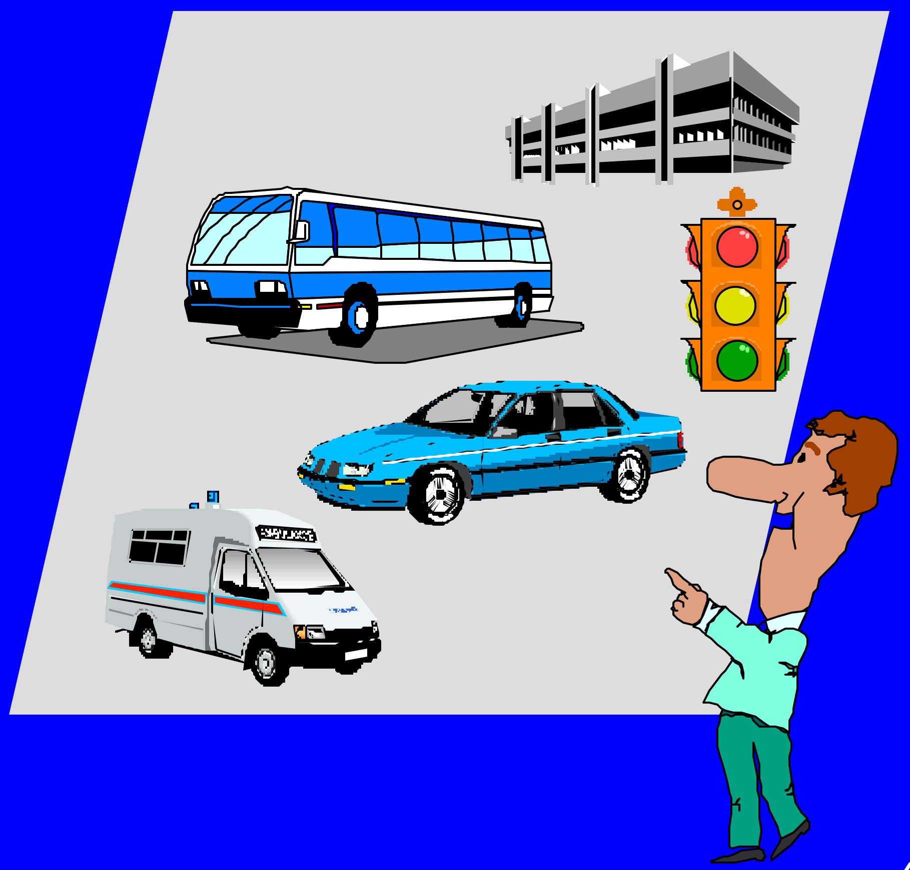
- Interface standards identification/coordination
- ITS complexity
- ITS integration



Architecture Development Team

National ITS Architecture Provides a Framework to Help ...

- Identify key stakeholders and interrelationships
- Describe required activities or functions
- Define interconnections and interdependencies between functions
- Develop a blueprint for integration of systems



Architecture Development Team

What does the National ITS Architecture Consist of?

User Services

Requirements
e.g. Incident Management

National ITS Architecture

Logical Architecture

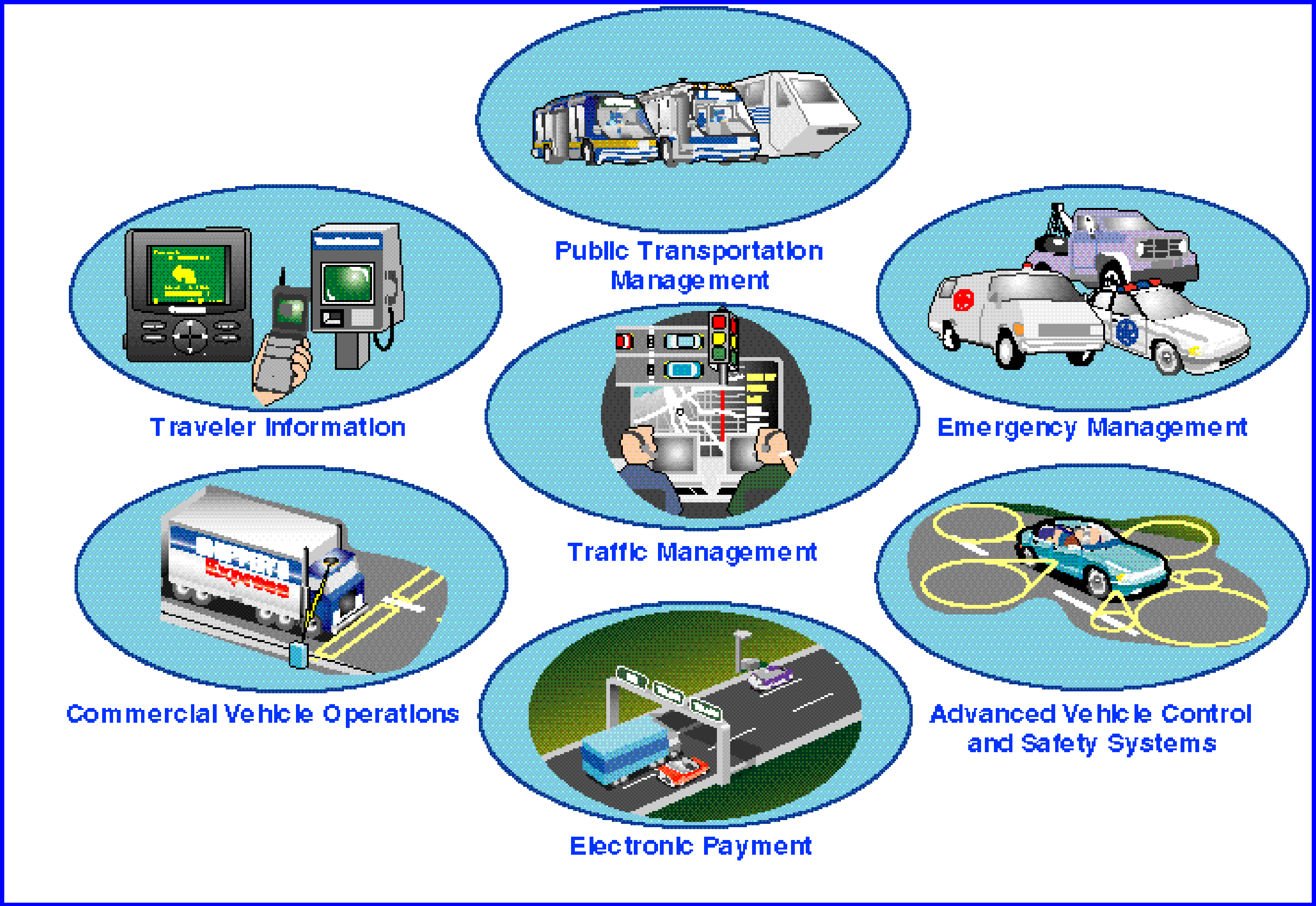
What functions?
e.g. Detect Incident
Verify Incident

Where are the functions?
E.g. Traffic Management Center

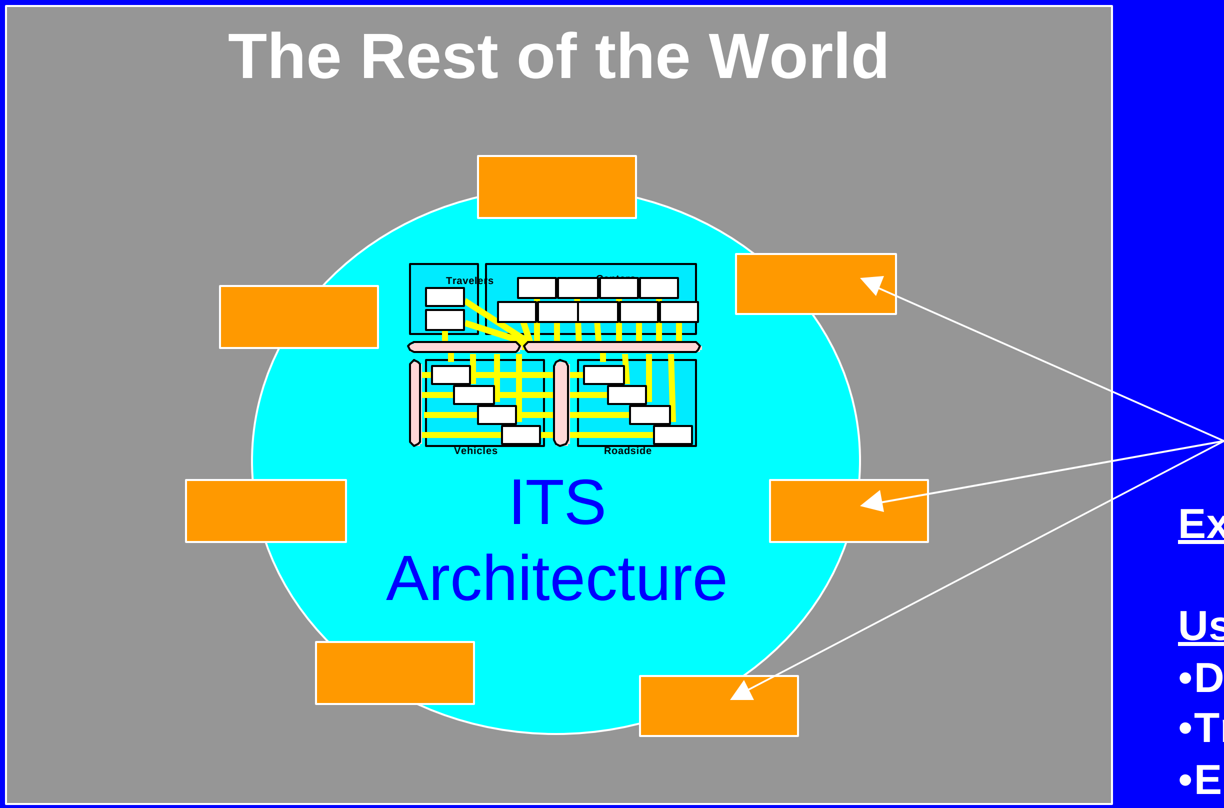
Physical Architecture

Architecture Development Team

ITS User Services are the basis for National ITS Architecture



Architecture has a Boundary



Terminators

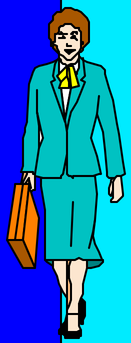
Example Terminators

Users
- **Driver**
- **Traffic Operations Personnel**
- **Emergency System Operator**

Other Systems:
- **Weather Service**
- **Financial Institution**

Architecture Development Team

Architecture Subsystems

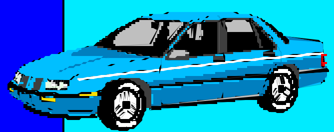


Travelers

- Remote Traveler Support
- Personal Information Access

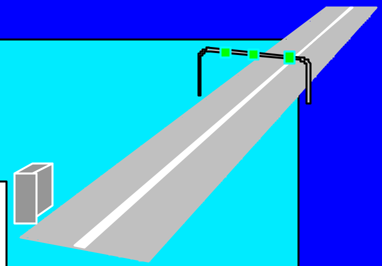
Centers

- Traffic Management
- Emergency Management
- Toll Administration
- Commercial Vehicle Administration
- Information Service Provider
- Emissions Management
- Transit Management
- Fleet and Freight Management
- Planning



Vehicles

- Vehicle
- Transit Vehicle
- Commercial Vehicle
- Emergency Vehicle

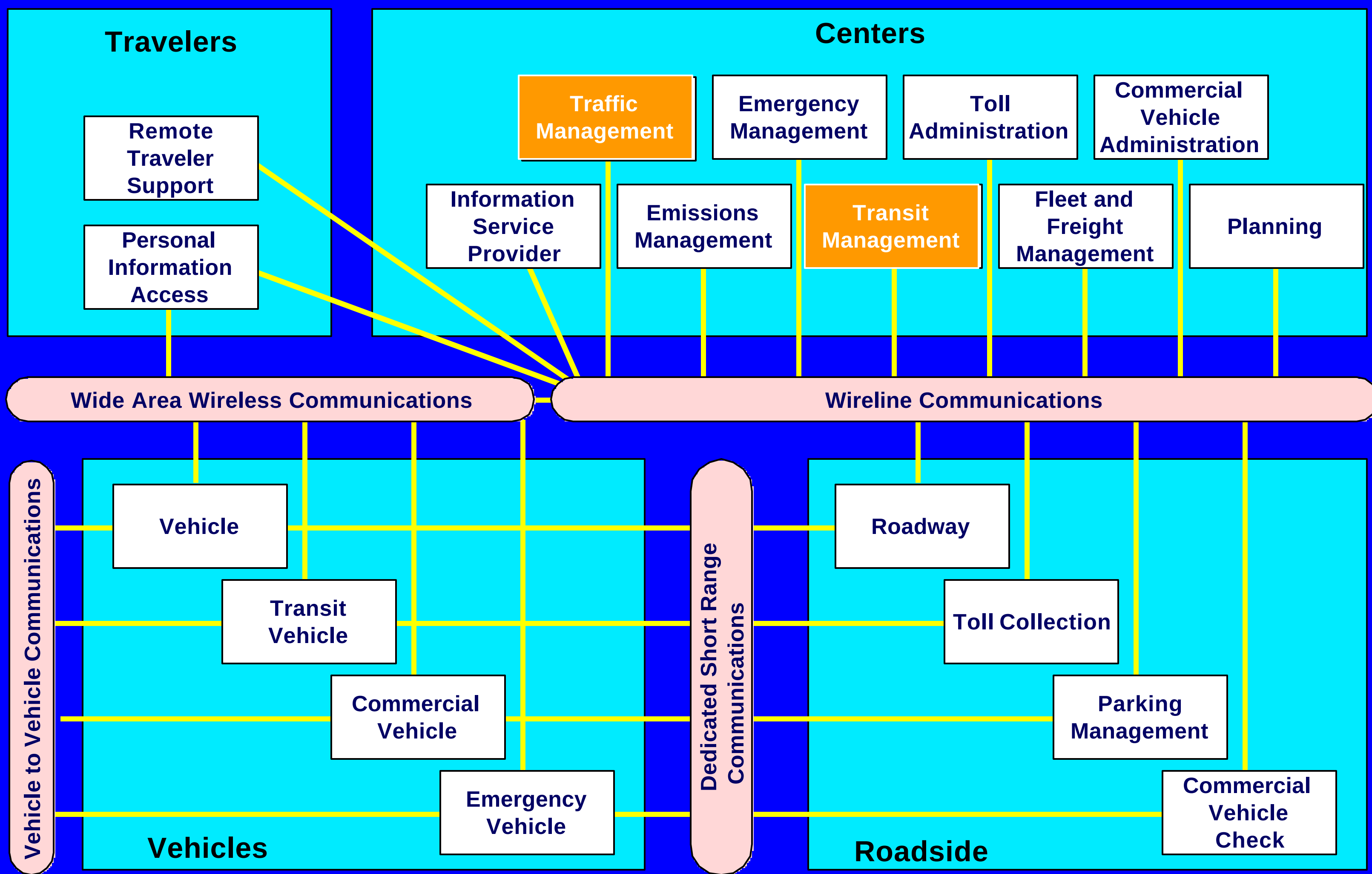


Roadside

- Roadway
- Toll Collection
- Parking Management
- Commercial Vehicle Check

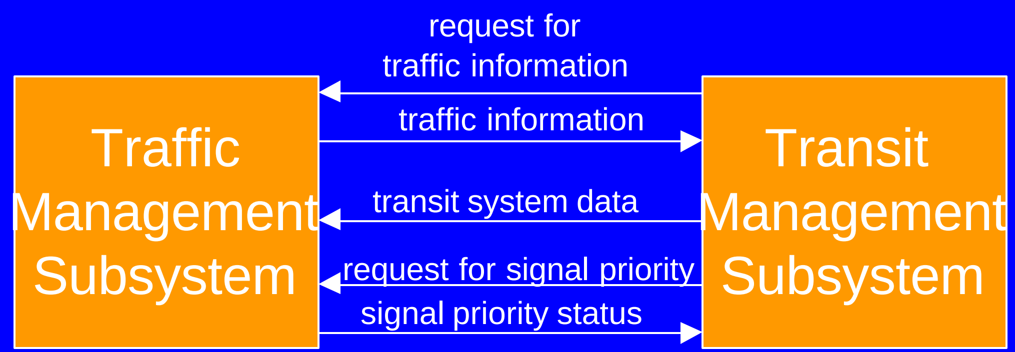
Architecture Development Team

Architecture Subsystems and Interconnects



Architecture
Development
Team

Next Level of Detail

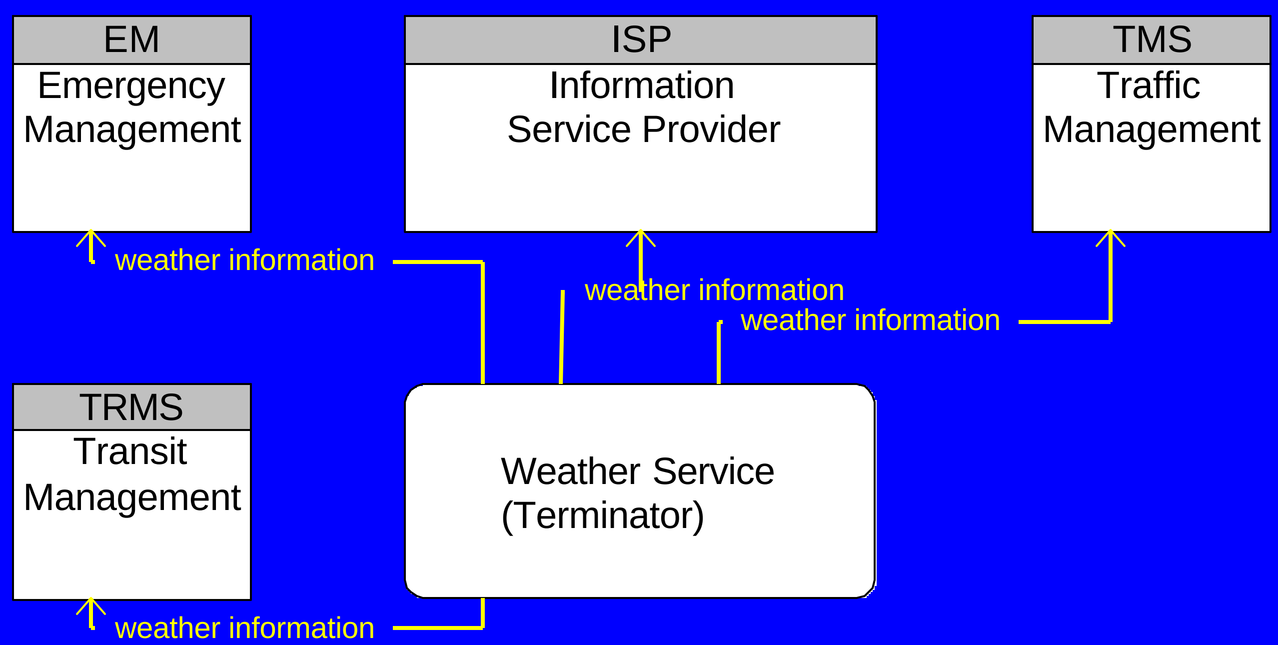


- High-level subsystem information exchange
- Considerations for integration

Architecture Development Team

Weather Information in National ITS Architecture

- Based upon limited requirements, very simple model of weather information dissemination



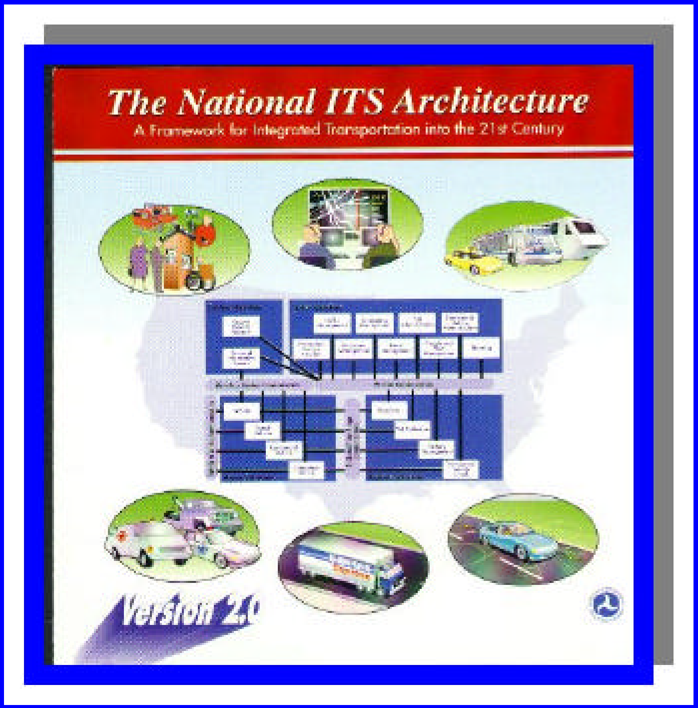
Architecture Development Team

How is the Architecture Used?

- As a Tool to Develop
  - Regional Architectures
    - Regional framework for ITS Integration
    - Helps you evaluate and understand options
  - Project Architectures
    - To identify and evaluate integration options when defining new ITS projects or expanding on current capabilities

ITS Architecture: How to Access

- CD-ROM
- Web site http://www.odetics.com/itsarch



User Services 1993

Phase I Competition 1994

Phase II 1995

Architecture Published 1996

HRI Update 1997

Version 2.0 1998

Version 3.0 2000

National ITS Architecture: Future Emphases

- Deployment Support
- Training
- Enhancement of the Architecture
  – Rural ITS Services focus
  – Other new User Services
- Support Standards and Testing Efforts
- Reflect US DOT and Stakeholder Activities back into the Architecture

Intelligent Transportation Systems: Evaluation and Assessment

Joseph I. Peters, Ph.D.

ITS Joint Program Office

U.S. Department of Transportation

Symposium on Weather Information for Surface Transportation

Silver Spring, Maryland

November 30 - December 2, 1999

What is ITS?

Applications of electronics, communications, and information processing products and services to solving surface transportation problems

Intelligent Vehicles

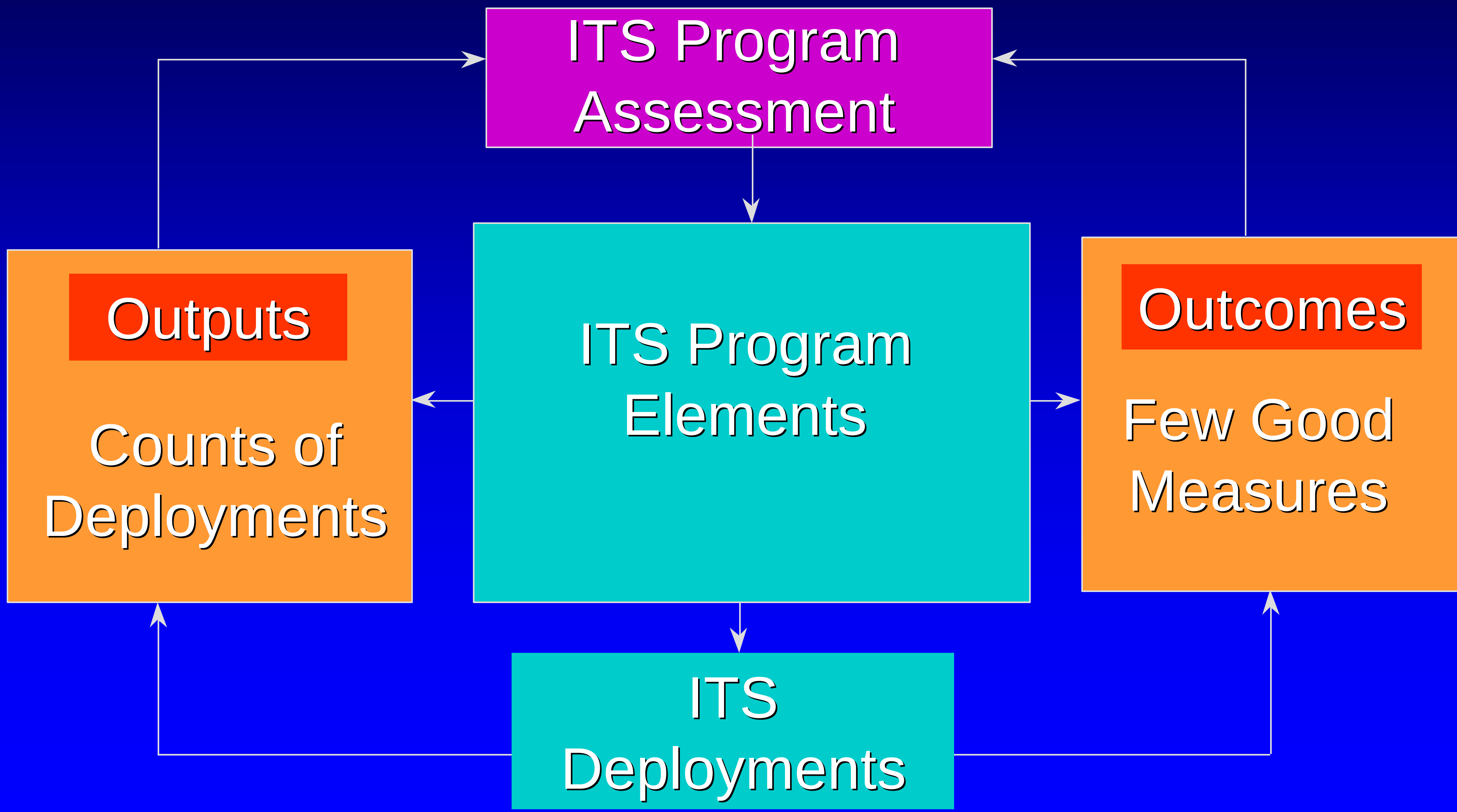
Intelligent Infrastructure

- Rural
- Commercial Vehicle
- Metropolitan

What is Rural ITS?

- Surface Transportation Weather and Winter Mobility
- Statewide/Regional Traveler Information Infrastructure
- Emergency Services
- Rural Crash Prevention
- Rural Transit Mobility
- Rural Traffic Management
- Highway Operations and Maintenance

How Are ITS Impacts Assessed?



What are the Outcome Measures?

Goal Area	Measure
Safety	Crashes/Fatalities
Efficiency	Throughput
Mobility	Travel Time Savings/Reliability
Productivity	Cost Savings
Energy & the Environment	Emissions Fuel Consumption

Customer Satisfaction Is The Bottom Line

How Do We Know What the Impacts Are?

- Research Studies
- Field Operational Tests
- Deployment Evaluations

WIST-Related Field Operational Tests

- Advanced Transportation Weather Information System
  - North Dakota, South Dakota
- FORETELL
  - Iowa, Wisconsin, Missouri
- Idaho Storm Warning System
  - Idaho
- Travel-Aid
  - Snoqualmie Pass, Washington State

Next Steps

- Define the Rural ITS Infrastructure Kick-off meeting:

  December 14, 1999

  8:30am - 4:00pm

  Room 3329, Nassif Building

  Washington, D.C.

Resources: WIST Brochure

- Available online:

  http://www.its.fhwa.gov/cyberdocs/welcome.htm
- Can be ordered:

  by phone: (202) 366-0722

  by fax: (202) 366-3302

  by e-mail: Kristy.Frizzell@fhwa.dot.gov
- Check these news sources for future publication dates:

  http://www.its.dot.gov & http://www.nawgits.com

Overview of U.S. Crashes & Weather Environment

Nov. 30-Dec.2, 1999

Dr. Keith Brewer

Office of Human-Centered Research
Research & Development
National Highway Traffic Safety Administration

People Saving People
Http://www.nhtsa.dot.gov

How Adverse Weather Contributes to Crashes

- Impairs Visibility
- Decreases Stability
- Reduces Controllability

Dust Storm, Fog, & Snow Video

People Saving People
Http://www.nhtsa.dot.gov

How Adverse Weather Contributes to Crashes

Impaired Visibility:

- Rain & Splash & Spray
- Fog
- Snow
- Dust Storms
- Glare

How Adverse Weather Contributes to Crashes

Decreased Stability:

- Spin out - Slippery Pavements
- Rollover - Cross Winds on Trucks, Trailers, Vans
- Buffeting - Gusts with Passing Trucks

NHTSA

People Saving People
Http://www.nhtsa.dot.gov

How Adverse Weather Contributes to Crashes

Reduced Controllability:

- Slippery Roads (Rain, Snow, Ice)
- Slick Spots (Bridges, Metal Plates, Oil)
- Hydroplaning (Heavy Rain)

Snow Crash

People Saving People
Http://www.nhtsa.dot.gov

Rain Crash

People Saving People
Http://www.nhtsa.dot.gov

NHTSA Crash Data

Fatality Analysis Reporting System (FARS)

- Census of Fatal Crashes (~37,000 per year)
- Police Accident Reports (~100 data elements)

National Automotive Sampling System (NASS)

- Sample of Crashes (~5,000 crashes per year)
- Crashes Investigated (~ 650 data elements)

NHTSA Crash Data

FARS & NASS:

Gold Standard of Crash Data Systems

BUT:

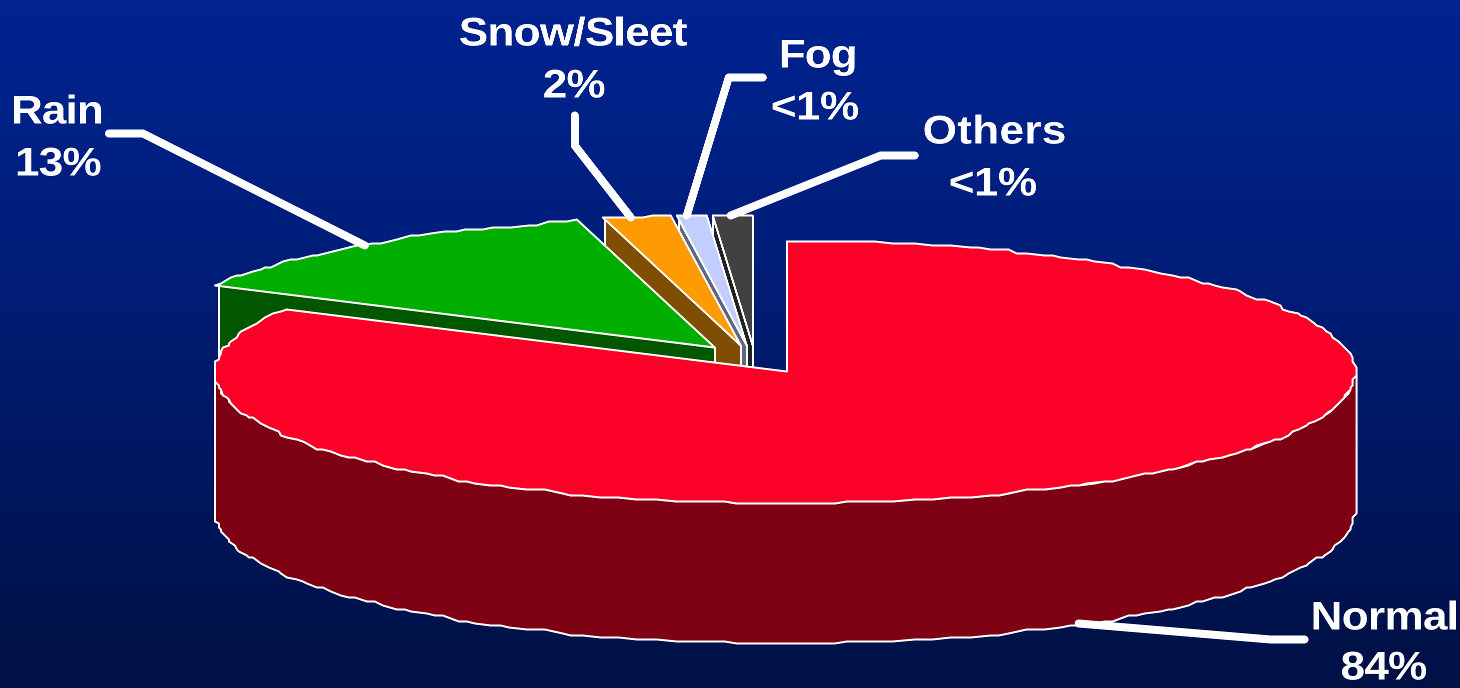
We lack exposure measures for Weather in terms of Vehicle Miles Traveled (VMT) under adverse weather conditions

Weather & Number of Police Reported Crashes (1998)

• Normal	5,329,000	*(84%)*
• Rain	827,000	*(13%)*
• Snow/Sleet	131,000	*(2%)*
• Fog	28,000	*(<1%)*
• Other*	20,000	*(<1%)*
• Total	6,335,000	

* Smog, Smoke, Sand, Dust

Weather & Number of Police Reported Crashes (1998)

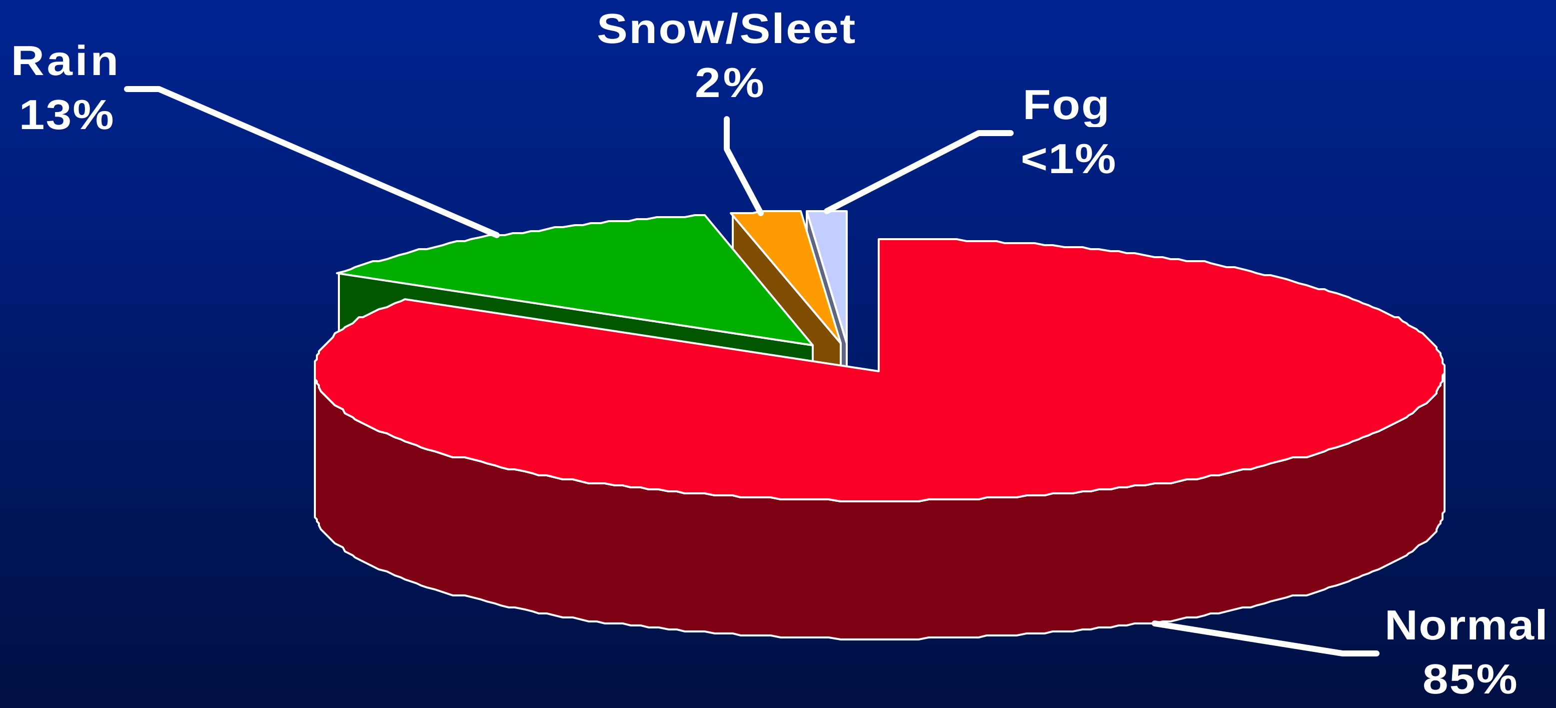


People Saving People
Http://www.nhtsa.dot.gov

Weather & People Injured (1998)

• Normal	2,709,000	*(85%)*
• Rain	420,000	*(13%)*
• Snow/Sleet	41,000	*(1.3%)*
• Fog	13,000	*(0.4%)*
• Other	9,000	*(0.3%)*
• Total	3,192,000	

Weather & Percent of People Injured in Crashes (1998)

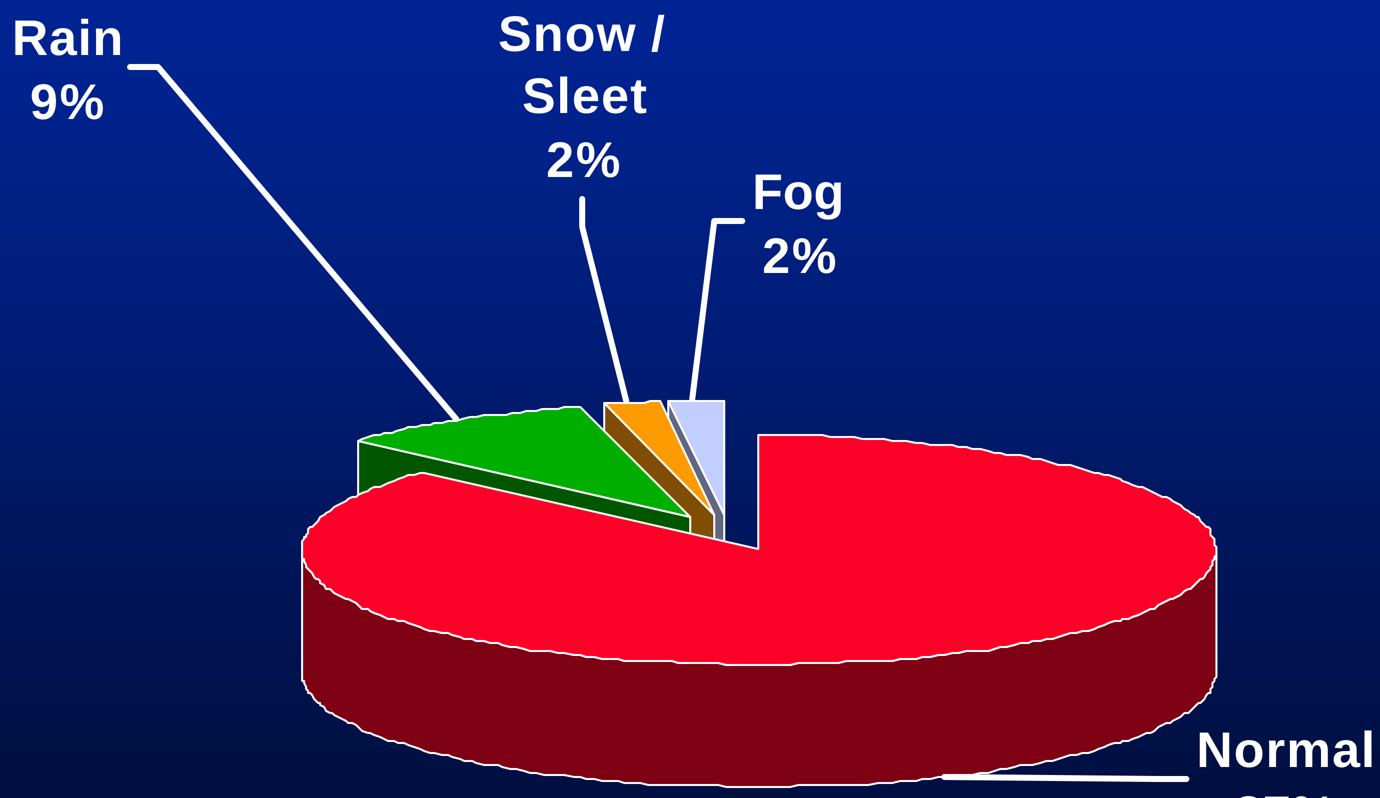


People Saving People
Http://www.nhtsa.dot.gov

Weather & People Killed (1998)

• Normal	36,076	*(87%)*
• Rain	3,644	*(9%)*
• Snow/Sleet	691	*(2%)*
• Fog	719	*(2%)*
• Other	341	*(<1%)*
• Total	41,471	

Weather & Percent of People Killed in Crashes (1998)



People Saving People
Http://www.nhtsa.dot.gov

Weather & People Killed (1989-1998)

	People Killed	
• Normal	362,473	*(87%)*
• Rain	37,649	*(9%)*
• Snow/Sleet	8,976	*(2%)*
• Fog	7,144	*(2%)*

Adverse Weather & Deaths by Vehicle Type (1989-98)

Involved **Vehicle**	**Total Deaths**	***Adverse***	***Percent***
• Passenger Cars	286,316	*39,622*	*13.8*
• Light Trucks	170,268	*23,984*	*14.1*
• Large Trucks*	50,877	*8,664*	***17.0***
• Motorcycles	25,987	*903*	*3.5*
• Buses*	3,239	*576*	***17.8***

**Commercial Vehicles Travel More in Adverse Weather*

NHTSA

People Saving People
Http://www.nhtsa.dot.gov

Weather & 1998 Estimated Economic Costs of Crashes

• Normal	$**126** billion	*(84%)*
• Rain	**20** billion	*(13%)*
• Snow/Sleet	**3** billion	*(2%)*
• Fog	<**1** billion	*(<1%)*
• Other	<**1** billion	*(<1%)*
• **Total**	**$150 billion/year**	

Adverse Weather + Adverse Road Conditions

- Adverse Weather (Rain, Snow, Fog, etc.)
- Adverse Road Conditions:

  Roadway Surface (Wet, Snow, Ice)
- Vision Obscured (Splash, Spray, Dust, etc.)

Adverse Weather + Adverse Road Conditions (1989-1998)

	Number	Percent
• Crashes	12,000,000	*(28%)*
• Injured	8,000,000	*(25%)*
• Killed	80,000	*(19%)*

Adverse Weather + Adverse Road Conditions Estimated Bottom Lines

• Crashes	~1,200,000/Year
• Injured	~ 800,000/Year
• Killed	~ 7,000/Year
• Economic Costs	~$42 Billion/Year

NHTSA's Efforts to Reduce Weather Contributions to Crashes

Federal Standards:

- Antilock Brakes for Trucks
- Windshield Wiping, Washing & Defrosting
- Vehicle Conspicuity
- Lighting and Signaling
- Tire Information on:

  Traction, Treadwear & Temperature

NHTSA Efforts to Reduce Weather Contributions to Crashes, Deaths & Injuries

Research:

- Antilock Brakes for Cars & Trucks
- Truck Splash & Spray Countermeasures
- Truck Conspicuity
- Lighting & Signaling Visibility
- Automatic Crash Notification (ACN)
- Weather & Driver Research on NADS

NATIONAL ADVANCED DRIVING SIMULATOR (NADS)

NHTSA

People Saving People
Http://www.nhtsa.dot.gov

For More Information

Http://www.nhtsa.dot.gov

Weather Information Support to Surface Transportation

Capabilities of The National Weather Service

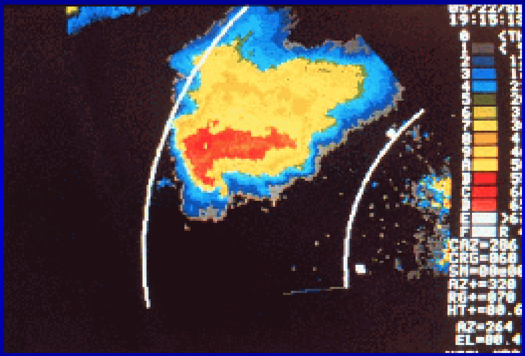
Greg Mandt
National Weather Service

Overview

- Mission
- Resource Environment
- Accomplishments
- Strategic Goals
- Forces of Change
- Capabilities Objectives
- Future Information
- Dissemination

NWS Mission

- Provide weather, water and climate forecasts and warnings
  - To America
  - To protect life and property
  - To enhance the national economy



- Provide a national information database for
  - Government agencies
  - Private sector
  - Public
  - Global community

NWS Fact Sheet

- FY 99 Annual Budget $662.5M
  - $563.7M in base operations
  - $89.3M in capital procurement
  - $9.5M in construction
- 4800 FTEs
- Labor accounts for over 66% of the annual base budget
- 172 Offices in the US
- 32% of NOAA's total budget
- The agency the public most identifies as NOAA

FY 1999 Accomplishments

- Completed Development & Deployment of Baseline AWIPS
- Issued New Climate Products
  - Threats Assessment
  - Hurricane Outlook
- Developed NWS Strategic Plan
- Improved warning performance

Forces Shaping Our Future

- Information Technology
- Weather, water, and climate prediction linkages
- Need to work better with partners and the private sector
- Continued demand for a more responsive and efficient government

Vision 2005 Goals

- Deliver better products and services
- Capitalize on scientific and technological advances
- Exercise global leadership
- Change the NWS organizational culture
- Manage NWS resources

Capabilities Objectives

- Use optimal mix of observations
- Implement prediction system advancements
- Implement probabilistic forecasts to aide user risk mitigation decisions
- Develop forecaster and user confidence

Future Weather Information

- Increased resolution and accuracy in both time and space
- More information flowing than ever before
- NWS digital database IS a product and service
- Evolutionize use of weather information

Dissemination to the Public

Primary NWS Methods

- *NOAA Weather Radio*
- *NOAA Weather Wire Service*
- *EMWIN (Emergency Managers Weather Information Network)*
- Internet (IWIN & Non-operational Pages)
- *NOAAPORT*
- Local Dissemination Port

Primary Private Sector Methods

- *Television*
- *Radio*
- *Internet*
- *Print*
- *Pagers*

Conclusion

- NWS has modernized
- Nation is already reaping benefits
- Much higher information flow
- Requires new product forms
- New media
- Surface transportation community will be an explicit beneficiary of evolving NWS capabilities

Milestones & Accomplishments

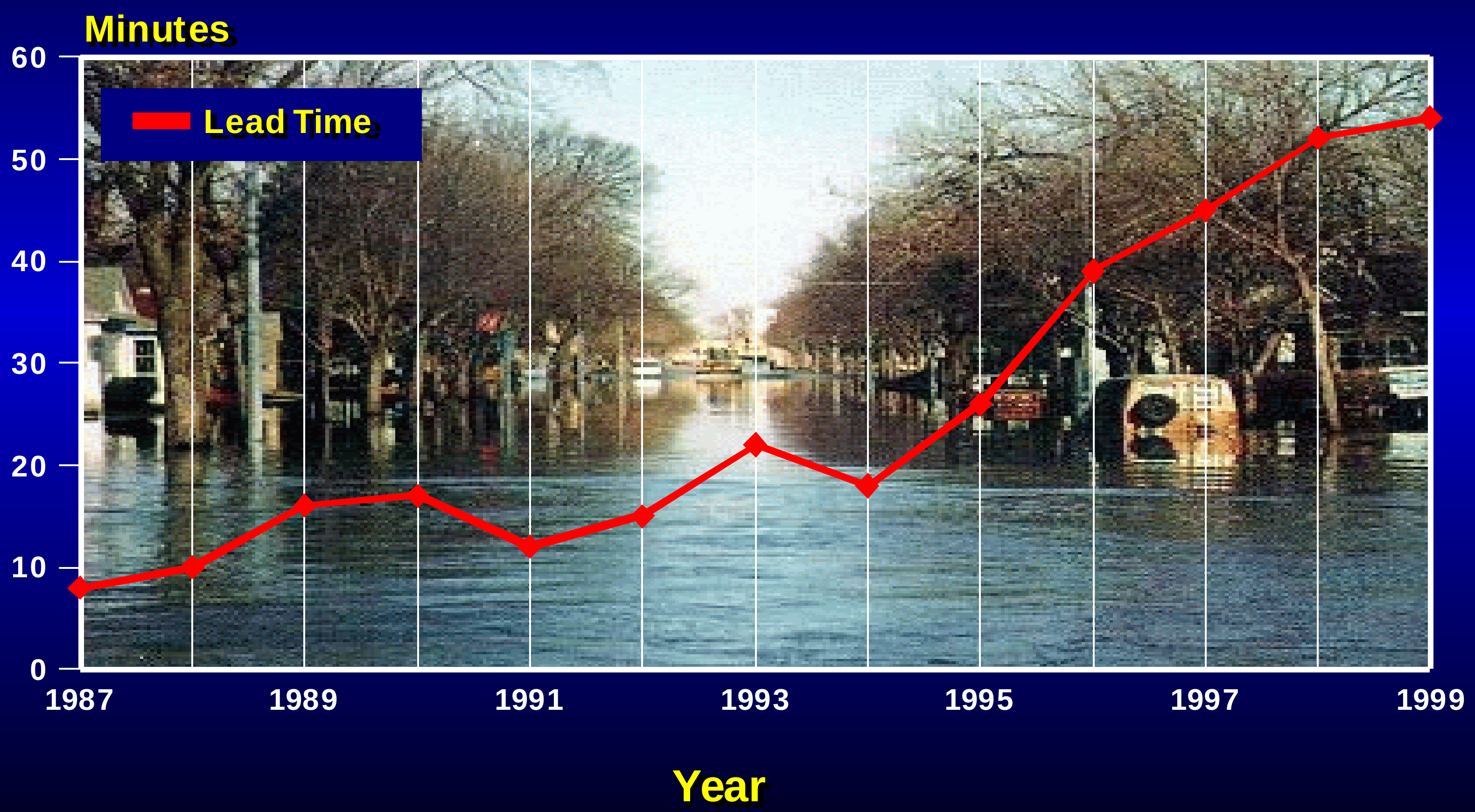
FY 1999 Accomplishments
Exemplary Services

- May 3 Central Plains Tornado Outbreak
- Record - Breaking January Tornadoes
- Tornado Warning Improvements
- Hurricane Floyd

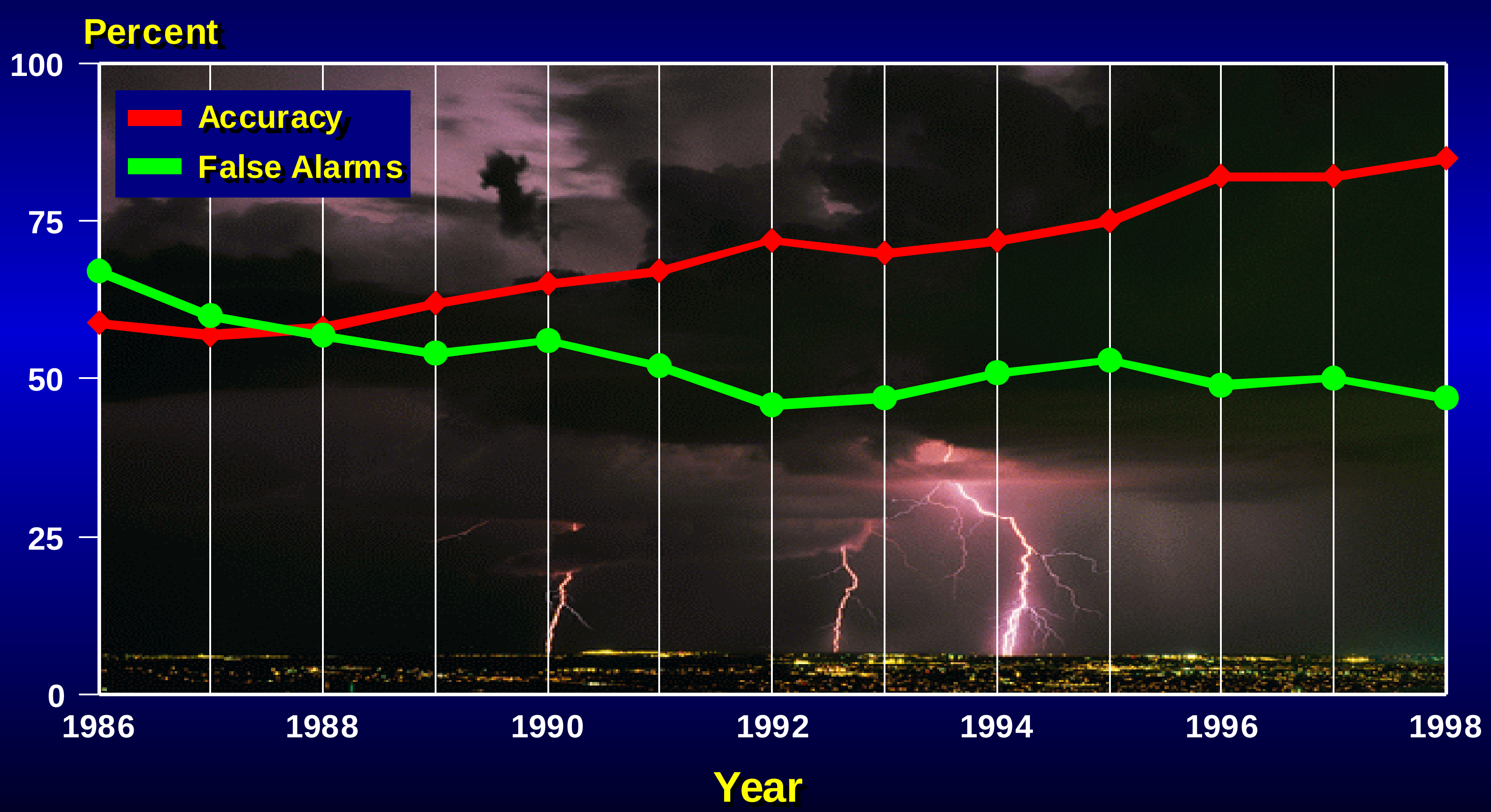
NWS Vision

- America's no surprise weather service
- A world class team of professionals who:
  - Produce and deliver quality forecasts you can trust when you need them most
  - Use cutting edge techniques
  - Provides services in a cost effective manner
  - Strive to eliminate weather related fatalities and improve the economic value of weather information

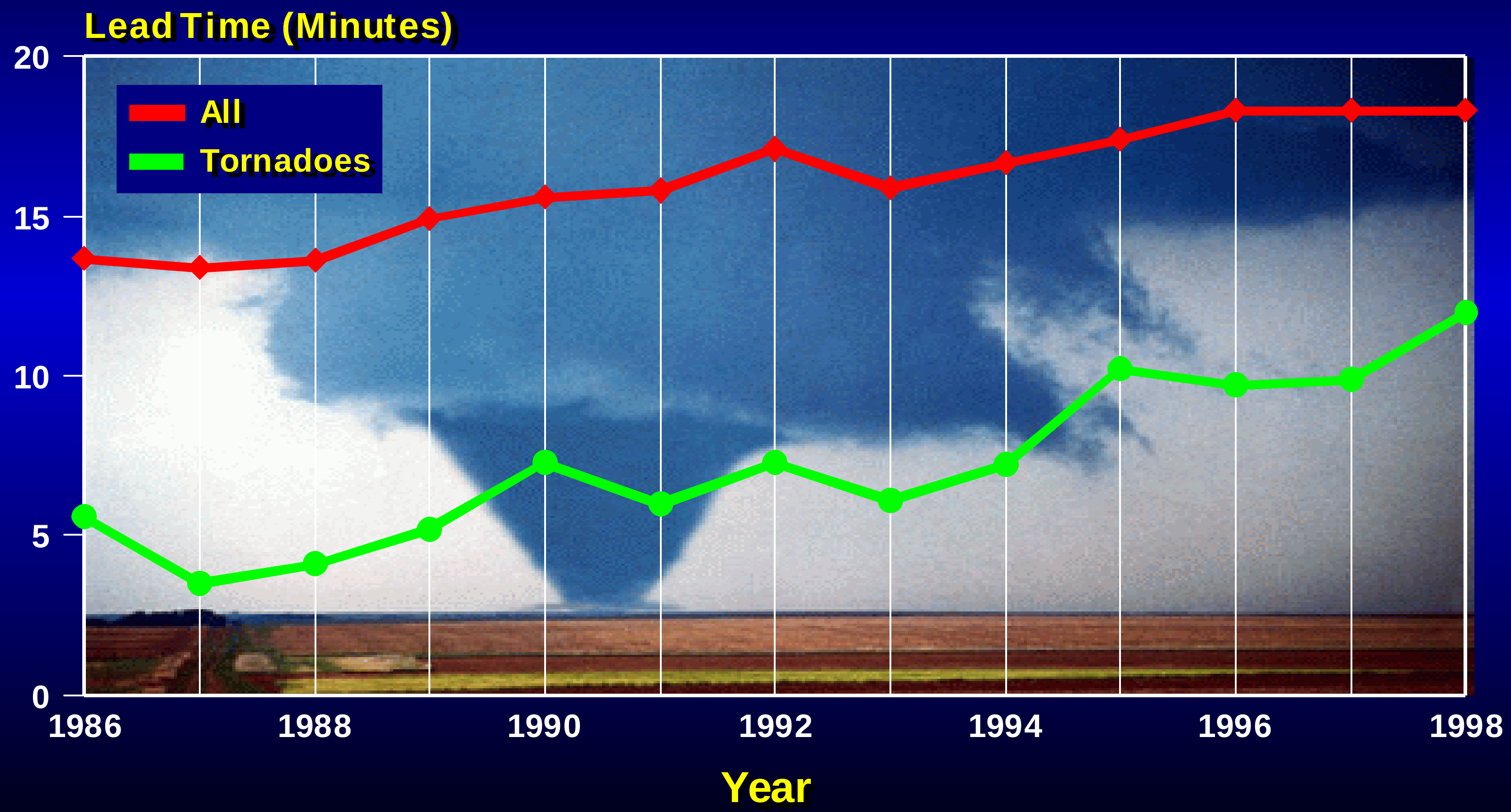
Flash Flood Warnings



Severe Thunderstorms And Tornadoes



Severe Thunderstorms And Tornadoes



… on our Nation’s team …

Weather Support for America’s War Fighters

Air Force Weather

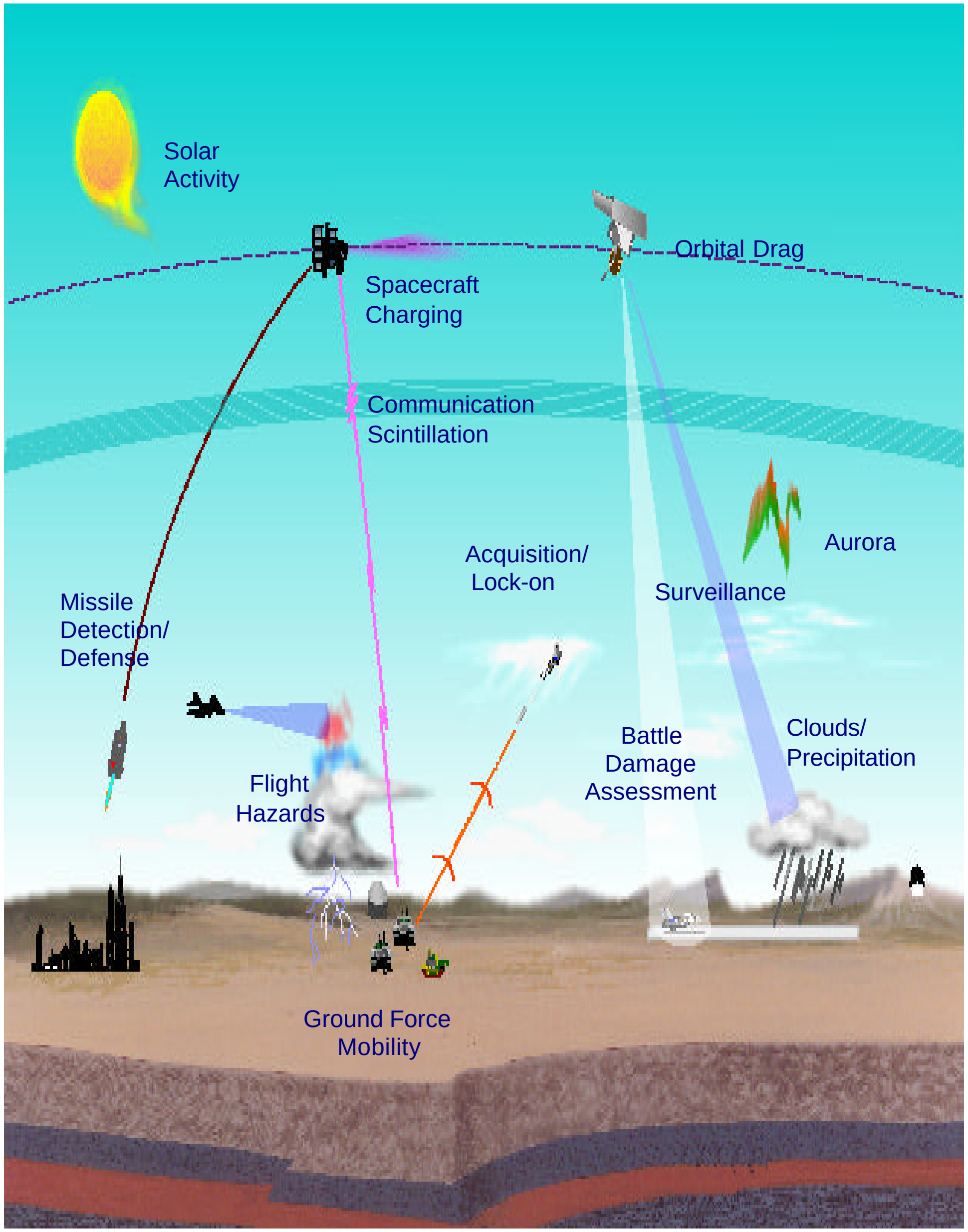
Colonel Michael A. Neyland

Deputy Director of Weather, HQ U.S. Air Force

Air Force Weather: Mud to the Sun

The people of Air Force Weather provide information, products and services that support air, land, and space operations

-- truly from the mud to the sun



AFW
MISSION STATEMENT

"Deliver the highest quality mission-tailored weather and space environment information, products, and services to our Nation's combat forces...anytime, anyplace...mud to the sun."

To accomplish the AF mission, forces must be able to engage and prevail globally, by operating in the air and space environment, which can either enhance or degrade the effectiveness of systems and operations. It is the AFW mission to provide the highest quality, mission-tailored weather and space information--anytime, anywhere-from the mud to the sun.

MILITARY METEOROLOGY

"Know the weather …"

… to plan military operations

… to assess enemy capabilities

… to execute the military mission

… to protect war fighting resources

"Know yourself, know your enemy;
your victory will never be endangered.
Know the ground, know the weather;
your victory will be total …"

Sun Tzu, 500 B.C.

MILITARY METEOROLOGY

WEATHER AFFECTS VIRTUALLY ALL HUMAN ENDEAVOR

"Know the weather …"

… to plan military operations
… to assess enemy capabilities
… to execute the military mission
… to protect war fighting resources

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MILITARY METEOROLOGY

Weather Services

Today's military air & space operations stretch from the surface of the Earth to the realm of space. Experience from the beginnings of armed conflict has proven that the awareness or ignorance of the effects of the natural air & space environment can have **a decisive impact on war.** Decisions are enhanced by commanders integrating knowledge of the weather into every facet of military operations. **By understanding the impacts of the environment, opportunities can be anticipated and exploited, and the effects of mission-limiting weather can be mitigated**.

MILITARY METEOROLOGY
Weather Services

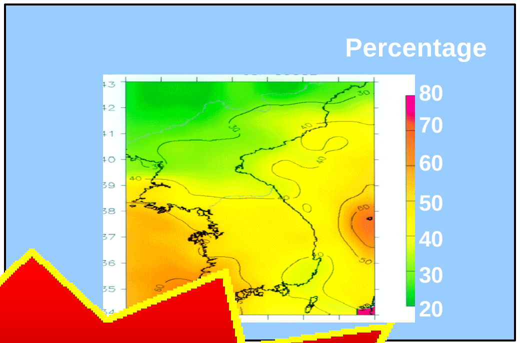
Today's military air & space operations stretch from the surface of the Earth to the realm of space. Experience from the beginnings of armed conflict has proven that the awareness or ignorance of the effects of the natural air & space environment can have **a decisive impact on war.** Decisions are enhanced by commanders integrating knowledge of the weather into every facet of military operations. **By understanding the impacts of the environment, opportunities can be anticipated and exploited, and the effects of mission-limiting weather can be mitigated**.

THE WEATHER ITSELF IS NOT NEARLY AS IMPORTANT AS WEATHER'S IMPACTS ON HUMAN ACTIVITIES

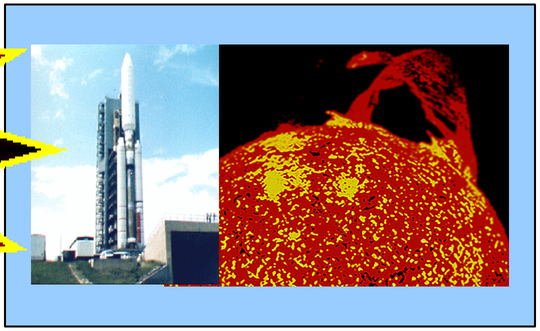
AFW: WHAT WE DO

Terrestrial Weather

Space Weather



Climatology



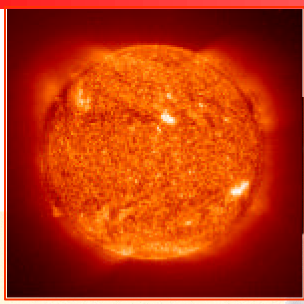
Ensuring DoD Operators can "Exploit the Weather"

"From the Mud to the Sun"

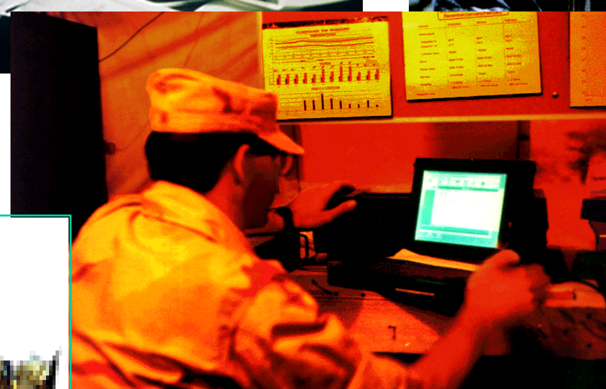
CORE PROCESSES
AIR & SPACE

ALL KEY TO PERFORMING AFW'S MISSION

ANALYSIS

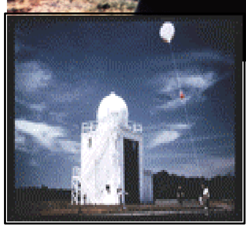


TAILORING



FORECASTING

DISSEMINATION



DATA COLLECTION

TERRESTRIAL WEATHER

Timely   Accurate   Relevant

DATA COLLECTION

- Surface / upper air obs
- Satellite soundings
- Cloud imagery (all METSATs)
- Radar / lightning data
- Space weather obs
- Nontraditional obs (GPS)

OUR MOST BASIC MISSION

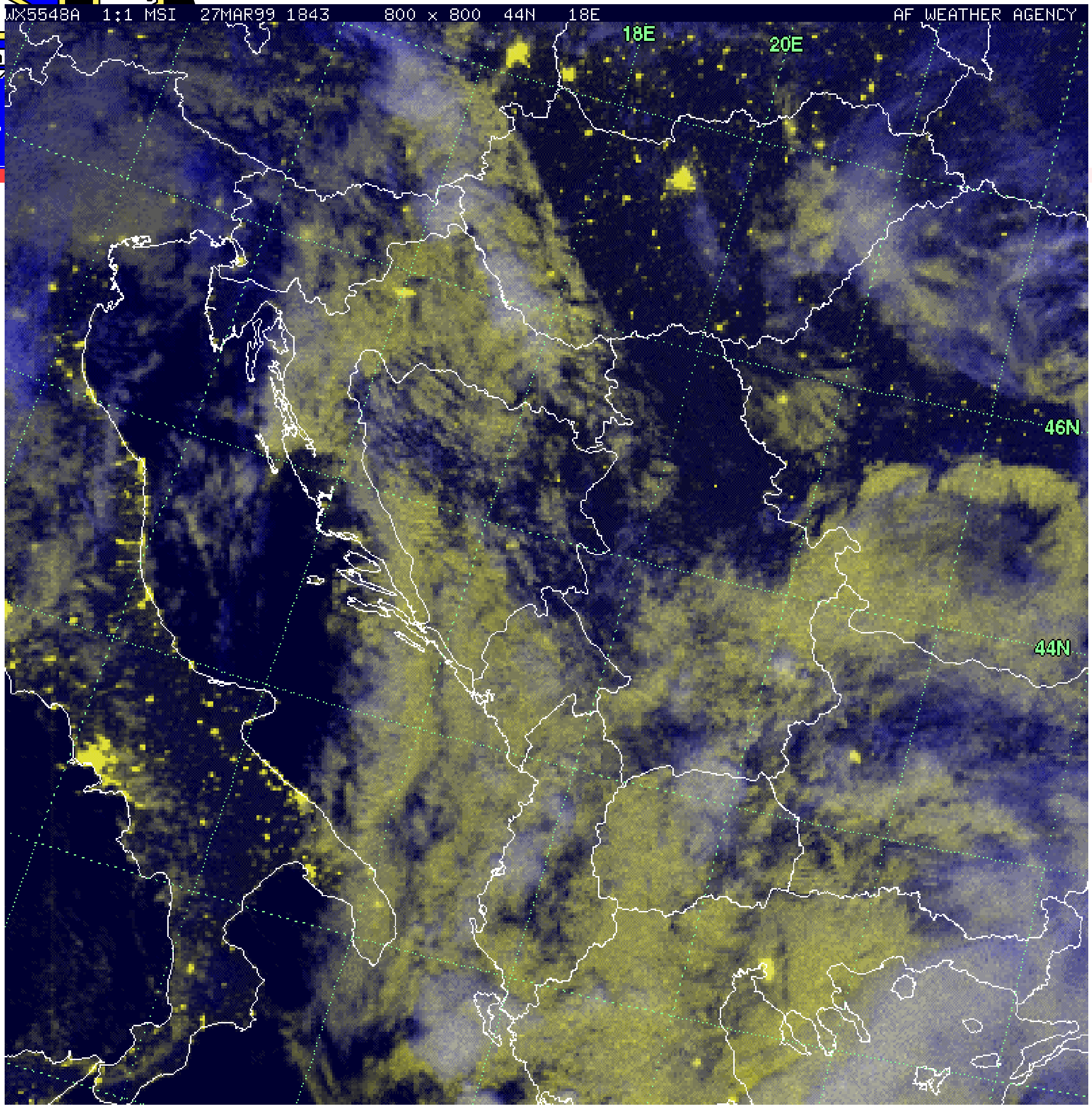
TERRESTRIAL WEATHER

Timely   Accurate   Relevant

Weather Parameters

- Temperature
- Humidity
- Winds
- Pressure
- Clouds
- Visibility
- Precipitation (Amount & Type)
- Cloud-free Line of Sight
- Severe Weather (tornadoes, hail, winds over 35 knots)
- Hazards
- Turbulence
- Icing

Multispectral DMSP Imagery



Operation Allied Force

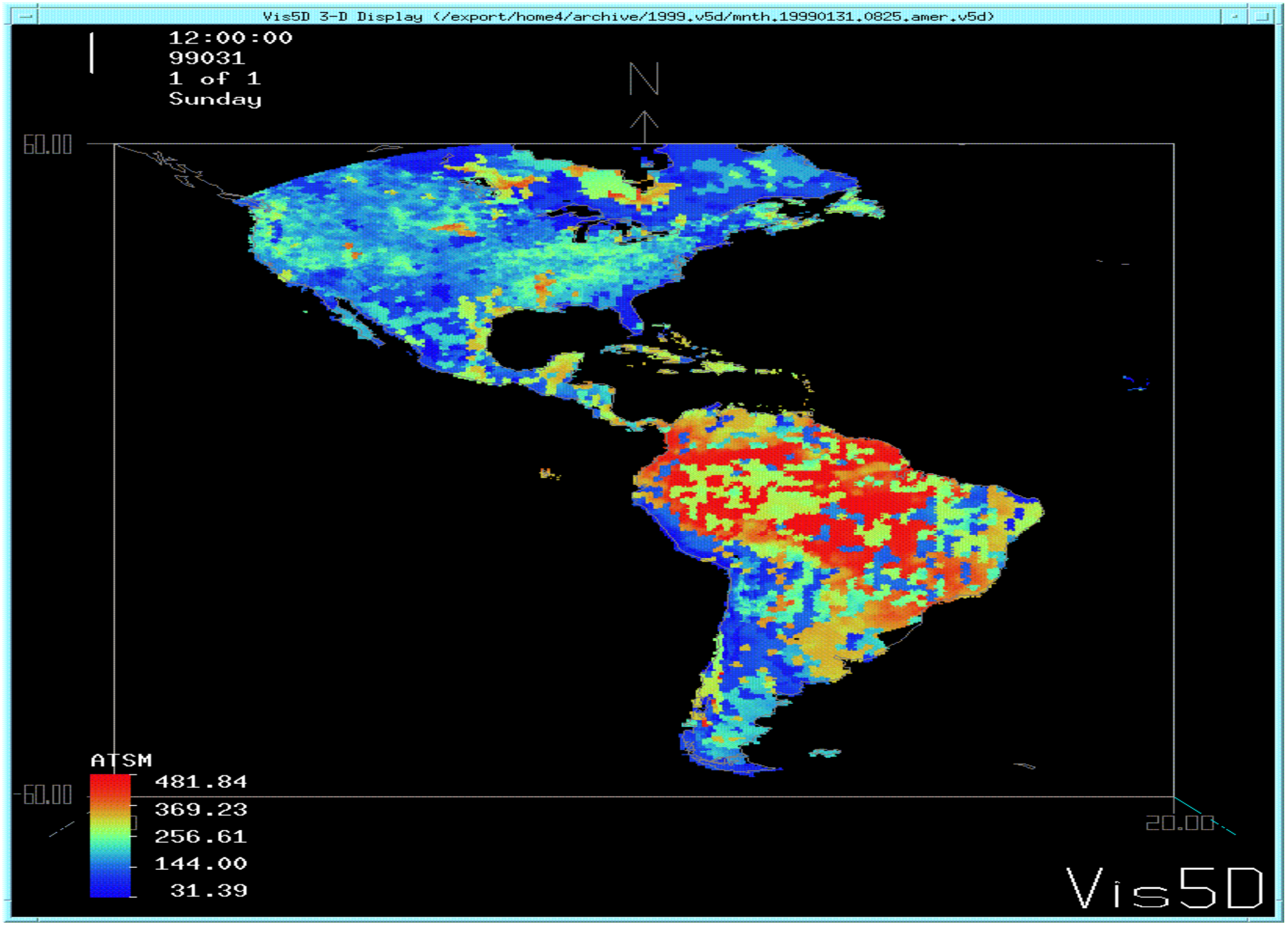
27 Mar 99

Agricultural Meteorology (AGRMET)

Jan 99 Top Soil Moisture

(Cubic inches of water / Cubic inches of soil sample)

Analysis of surface parameters (soil moisture, etc.)



TERRESTRIAL WEATHER

Timely   Accurate   Relevant

NUMERICAL WEATHER PREDICTION PROCESS

- **Application models (use output from global and theater fine-scale models)**
  - **Cloud forecasts, thunderstorm forecasts**
  - **Aviation and maneuver parameters**
  - **Slant path profiles, cloud-free line of sight**
  - **Agricultural meteorological analysis**
  - **Tactical decision aids**

TERRESTRIAL WEATHER

Timely   Accurate   Relevant

- Support to US Army/AF Ground Operations
  - Trafficability
  - Ground/Aviation Ops in Lowest 3000 Ft
  - Valley-By-Valley Ops
  - EO weapons and sensor support
  - Snow Cover
  - River Flooding
  - Soil Conditions
  - Terrain/Vegetation
  - Vehicle Operations
  - Troop Movement
  - Axes of Advance

TERRESTRIAL WEATHER

Timely Accurate Relevant

- Resource Protection
  - Precise forecasts of threatening weather conditions that endanger people, resources, or operations
  - Tornadoes
  - High Winds
  - Hail
  - Lightning
  - Floods
  - Heavy Snow/"Blizzard"
  - Excessive Temperatures
  - Sand Storm

SPACE WEATHER

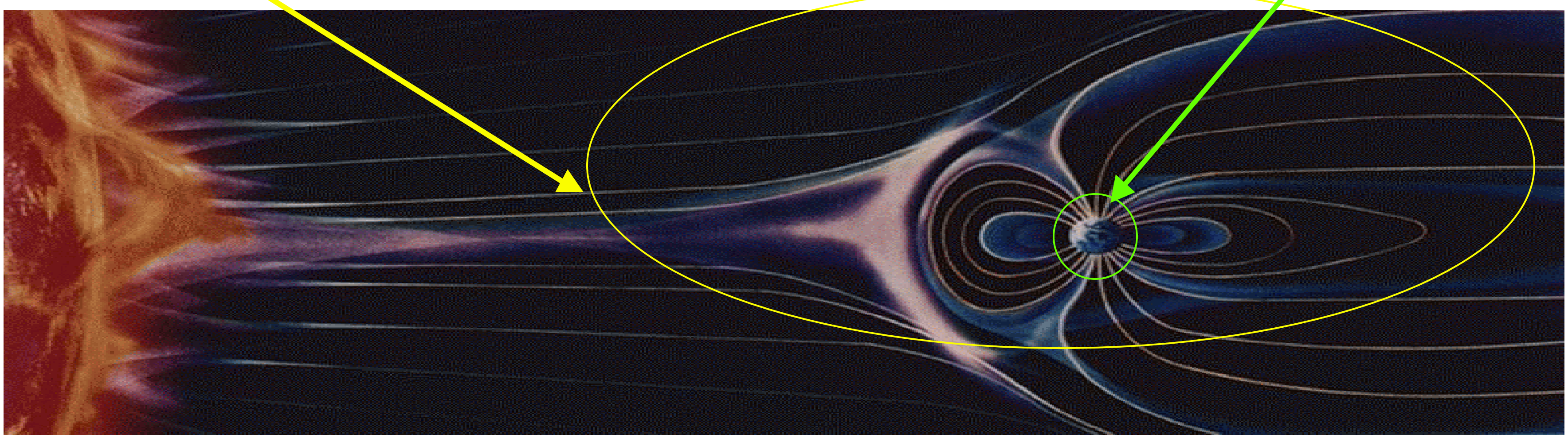
Key to 21st Century Warfare

Weather - - Environmental Disturbances Generated by the Sun

Space Weather

Seamless Battlespace Environment

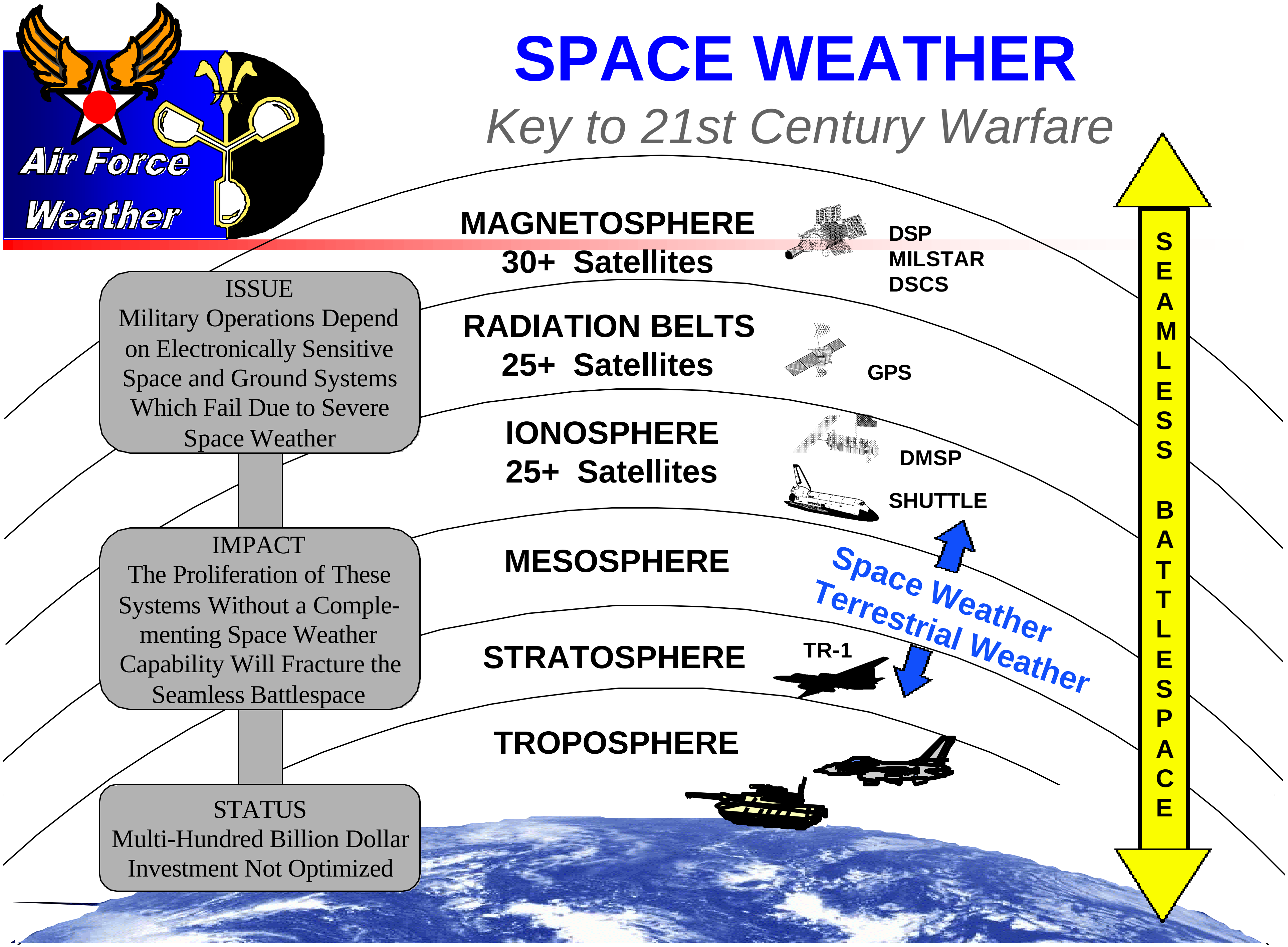
Terrestrial Weather



Space Weather: Electromagnetic radiation and electrically-charged particles stream outward from the sun, envelop the earth, and interact with the earth's magnetic field and terrestrial atmosphere creating an adverse environment.

SPACE WEATHER

Key to 21st Century Warfare



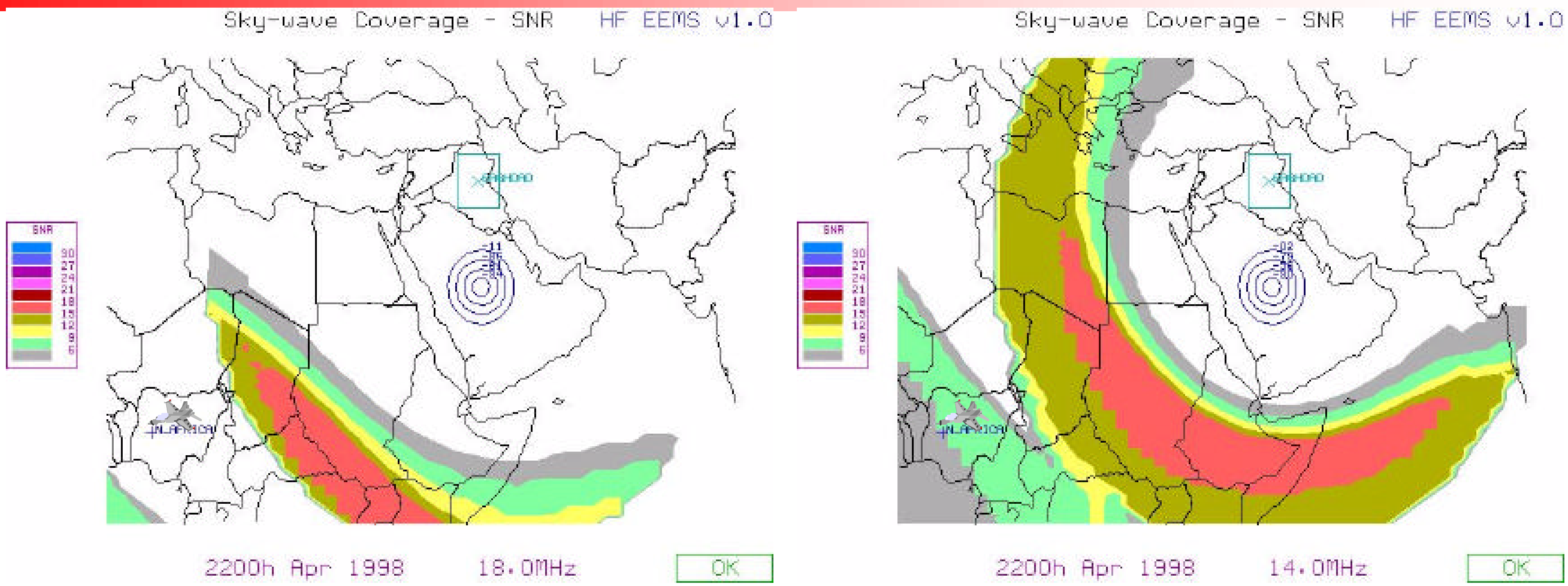
ISSUE
Military Operations Depend on Electronically Sensitive Space and Ground Systems Which Fail Due to Severe Space Weather

IMPACT
The Proliferation of These Systems Without a Complementing Space Weather Capability Will Fracture the Seamless Battlespace

STATUS
Multi-Hundred Billion Dollar Investment Not Optimized

TECHNOLOGIES:
Space Weather

HF Illumination Maps
Scenario #1: Link Establishment



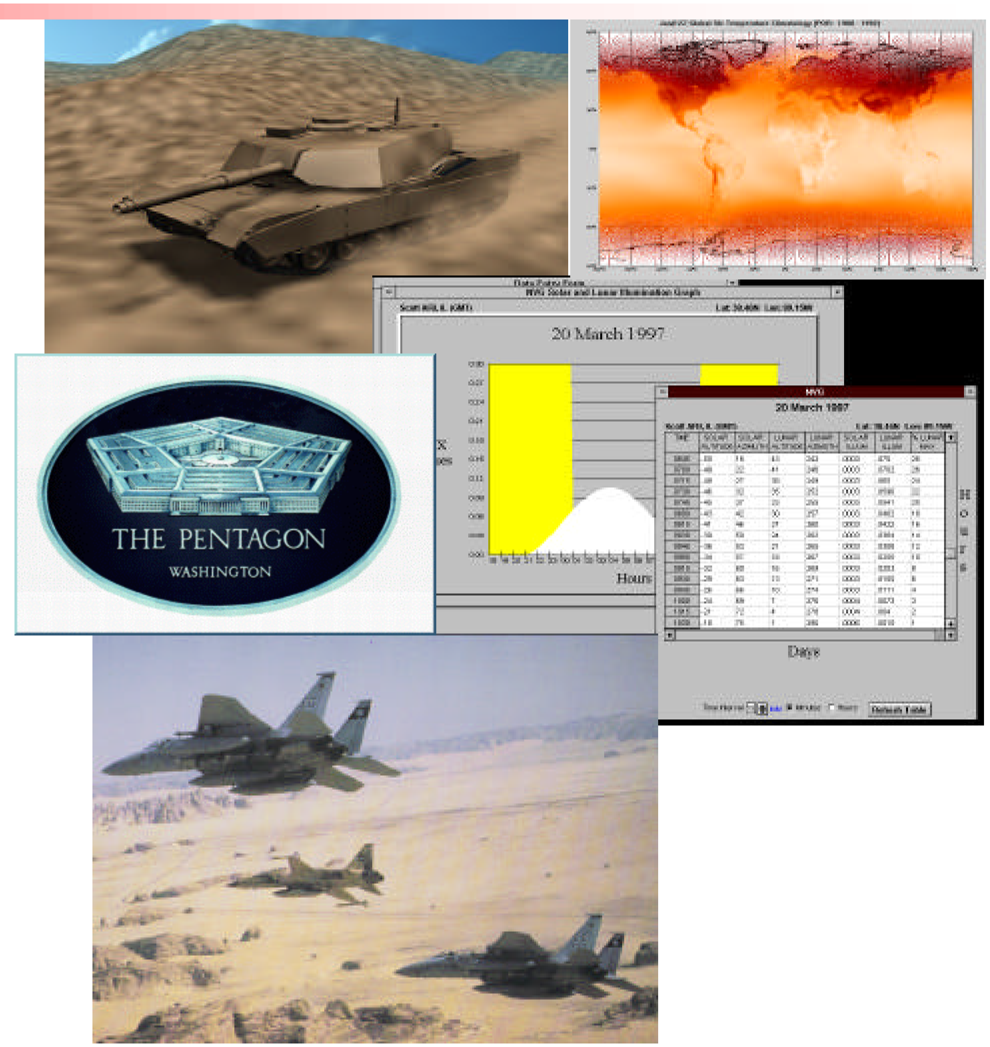
- Correct frequency selection allows HF link establishment
- Illumination maps also facilitate jammer location, sigint denial, and enhanced OTH surveillance

Air Force Weather

CLIMATOLOGY

Key to Effective Planning

- "Long Range" forecasts
- Planning / Operations climatology assessments (operational weather impacts)
- Short-notice contingency response planning information
- Engineering design and employment of weapons systems



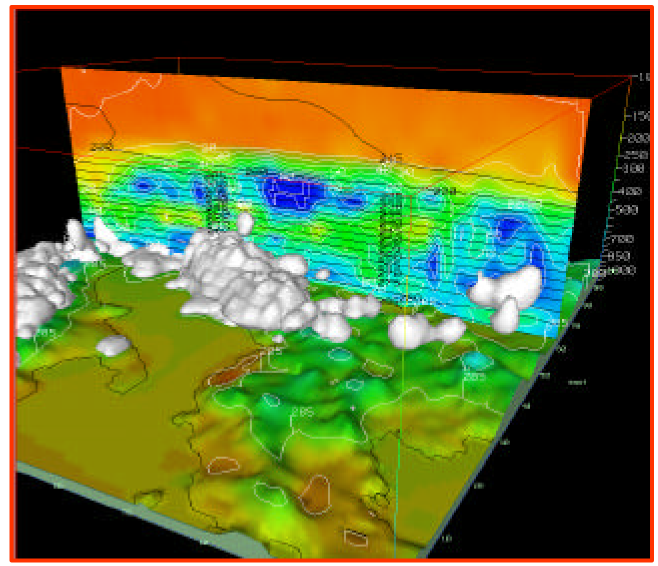
LEVERAGING TECHNOLOGIES
Enable Us to Excel

- **Leveraging National and Commercial Capabilities**
  - **Navy-Air Force cooperation agreement**
  - **Air Force-Army partnering continues strong (ARL support)**
  - **Federal agency partnerships**
    - **AFW provides backup support to SPC, AWC, NCEP**
    - **FAA and DOA partnerships**
  - **Universities, researchers & contractors**
- **Mission-Scale Meteorology**
  - **Operationalized, fine-scale models**
  - **Meteorological satellite & space weather expertise**
  - **Weather effects visualization**

LEVERAGING

Weather Forecast Models

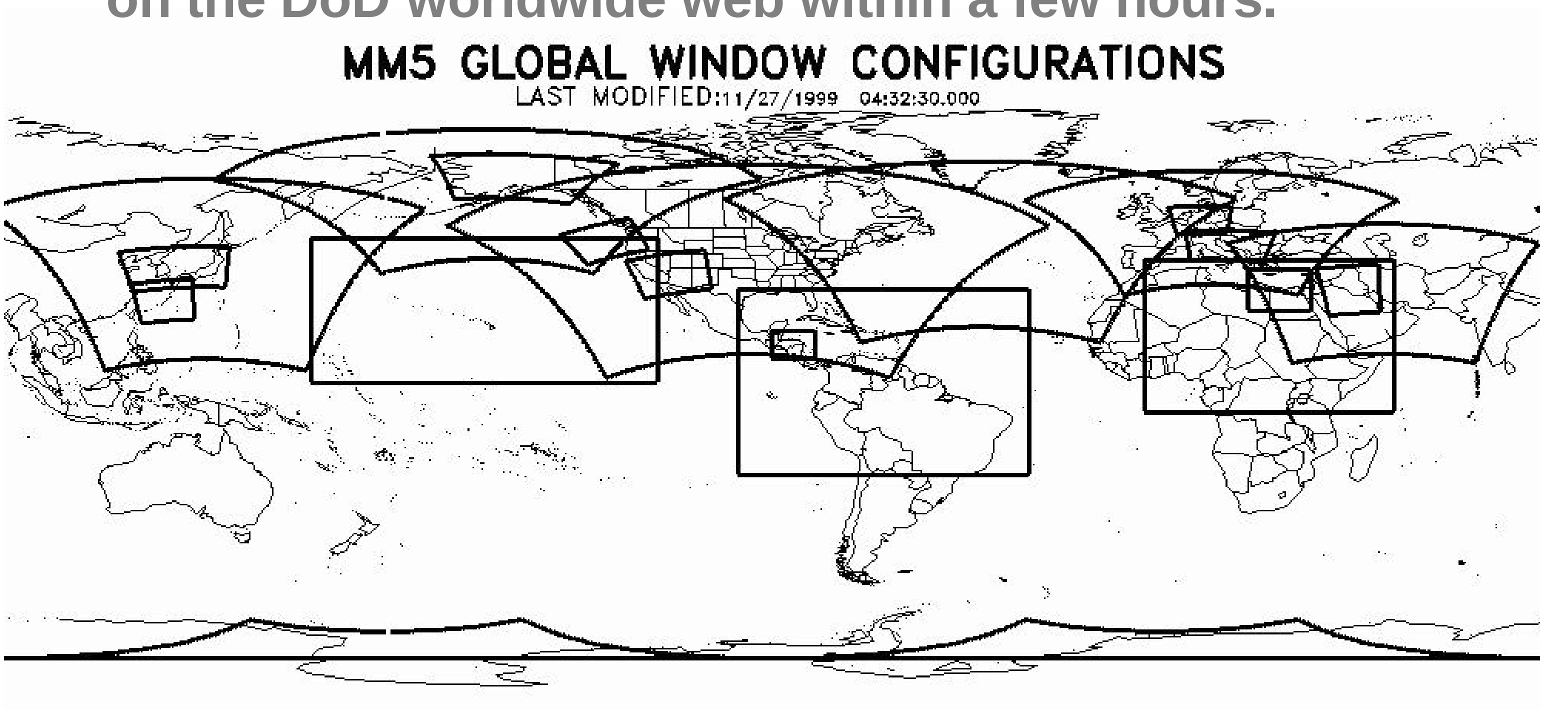
- **NOAA & Navy run global, large scale forecast models.**
  - Used to forecast large-scale (global) weather systems
  - AFW uses output from NOAA & Navy
- **AFW runs High Resolution Mesoscale and Specialized Weather Models**
  - Used to forecast smaller scale weather systems
  - NOAA and research community develops mesoscale models
  - AFW adapts models for daily use to support worldwide military operations with fine-scale, accurate, relevant wx info



TECHNOLOGIES

FOCUS ON SIGNIFICANT EVENTS / WEATHER

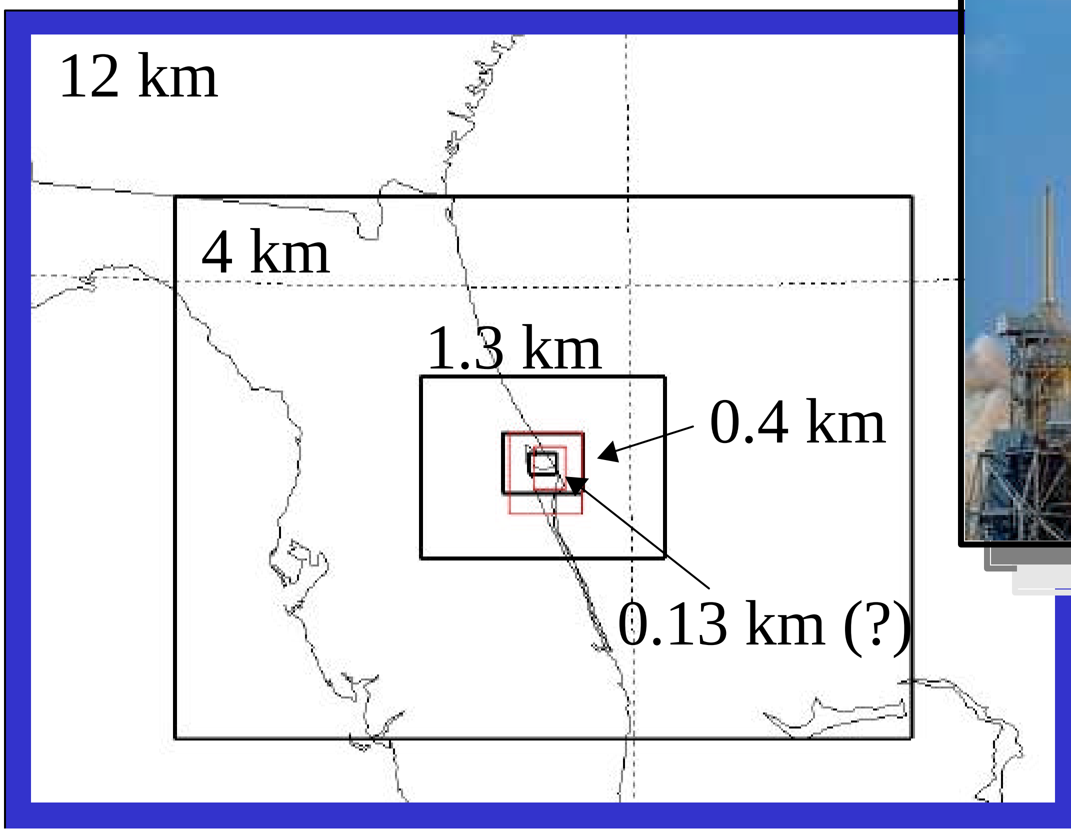
Precision Forecasting … Anywhere, Anytime!
Rapidly relocate fine-scale analysis and forecast windows around the world. Visualization products on the DoD worldwide web within a few hours.



Typical MM5 Window Locations

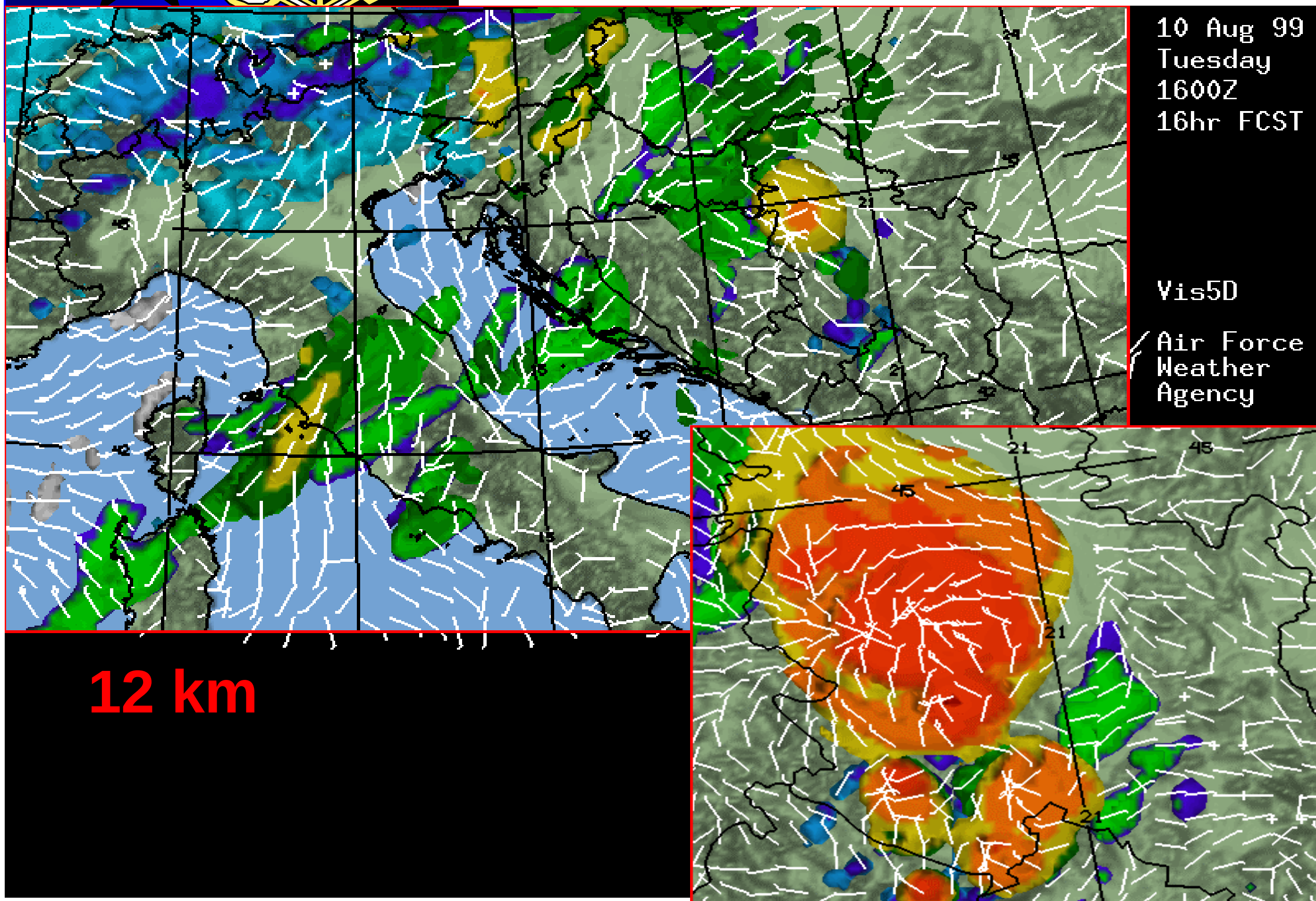
Another Window Possibility Space Shuttle Launch or Operational Target

Finest resolution for critical forecasts

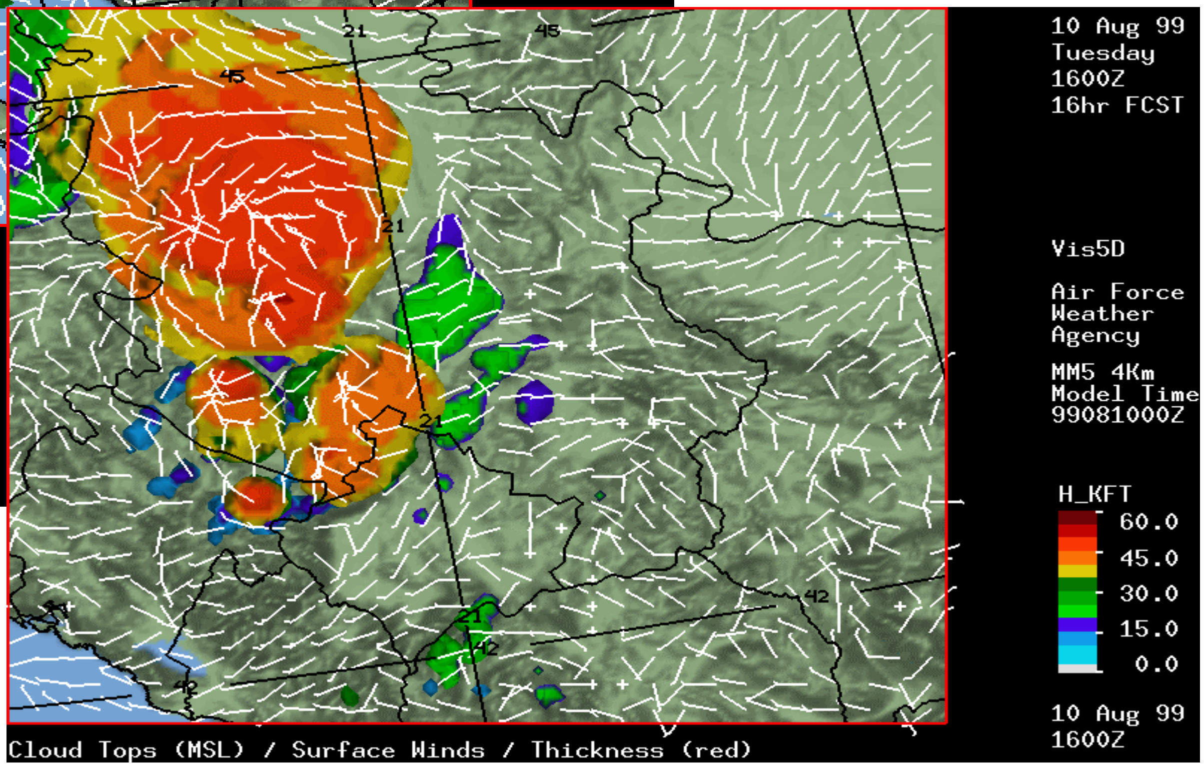


TECHNOLOGY

FINE-SCALE FORECASTING MODELS



12 km

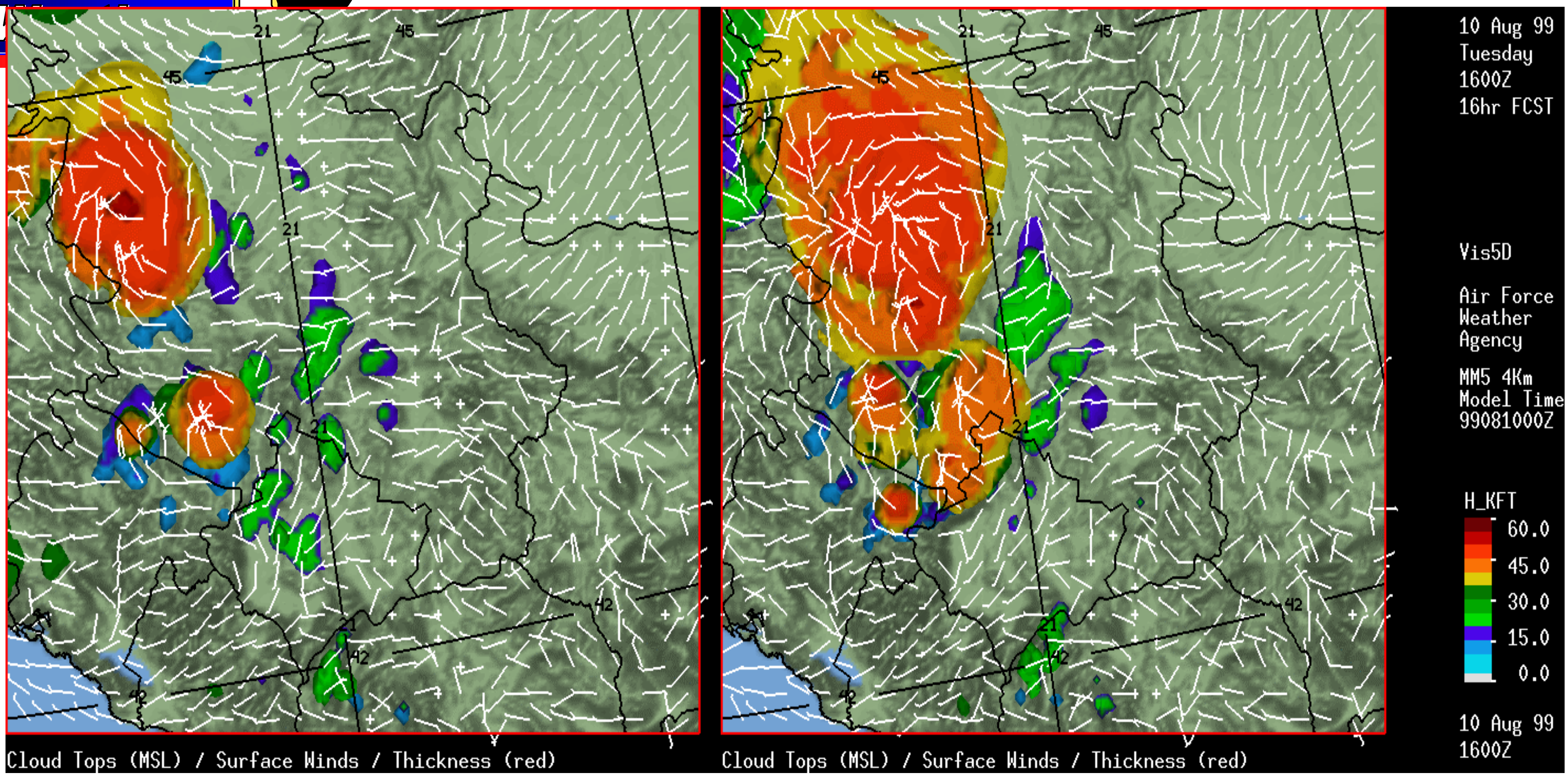


4 km

TECHNOLOGY

FINE-SCALE FORECASTING MODELS

4 km MM5



15Z 10 Aug

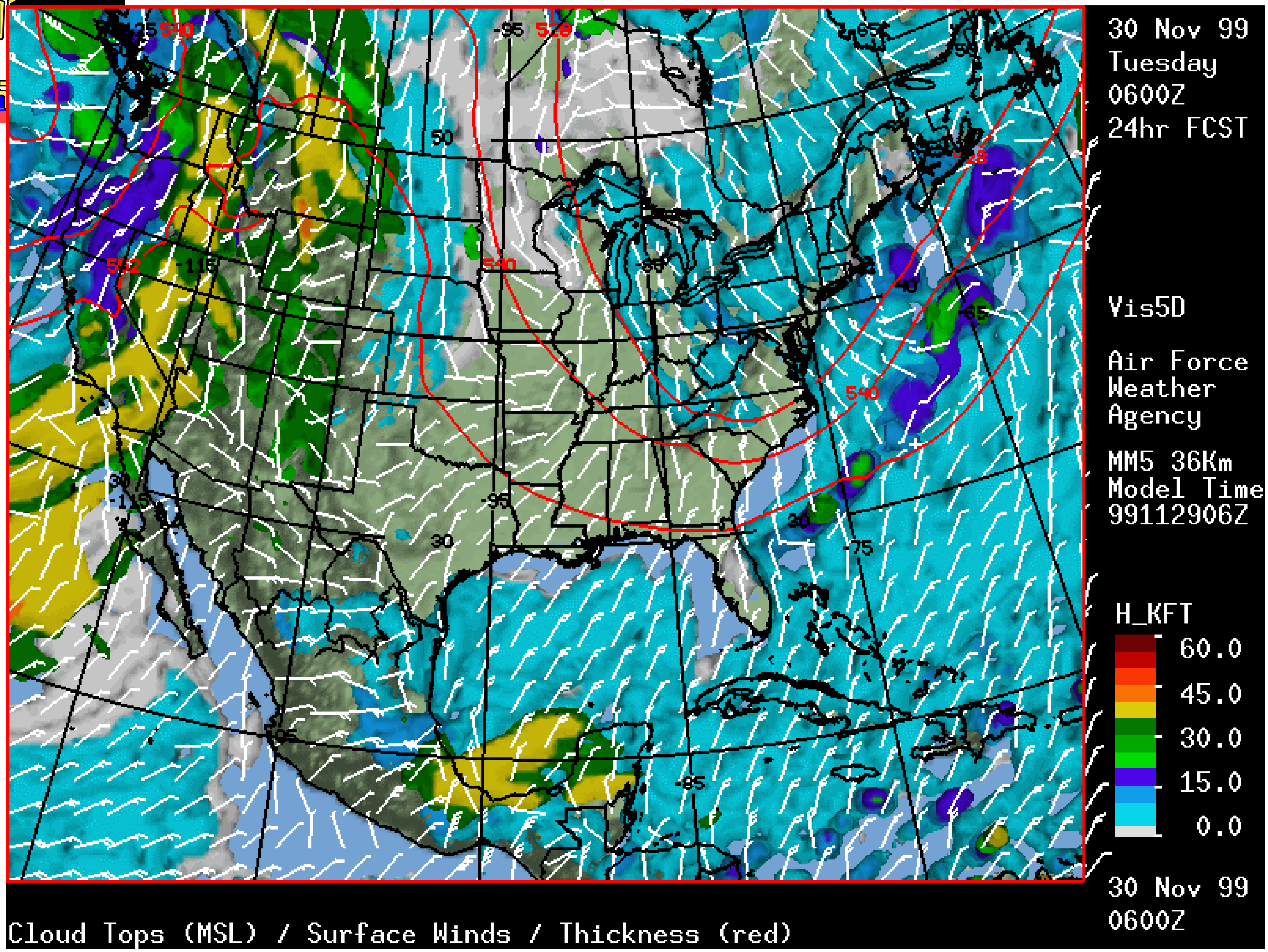
16Z 10 Aug

Balkans

Air Force Weather

MM5 36km Cloud Tops/Surface Winds

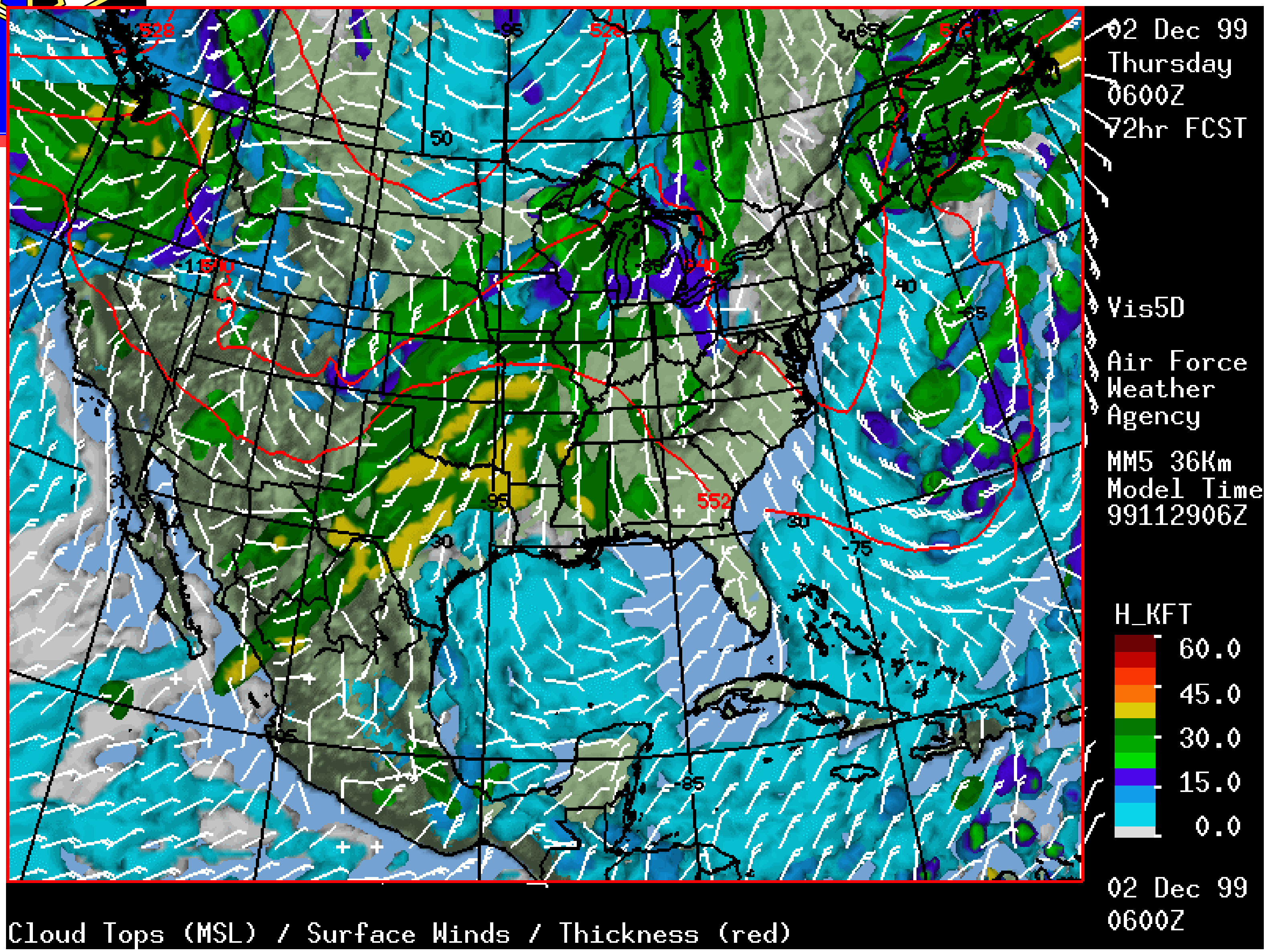
24 Hr Forecast Valid 30 Nov 06Z



Air Force Weather

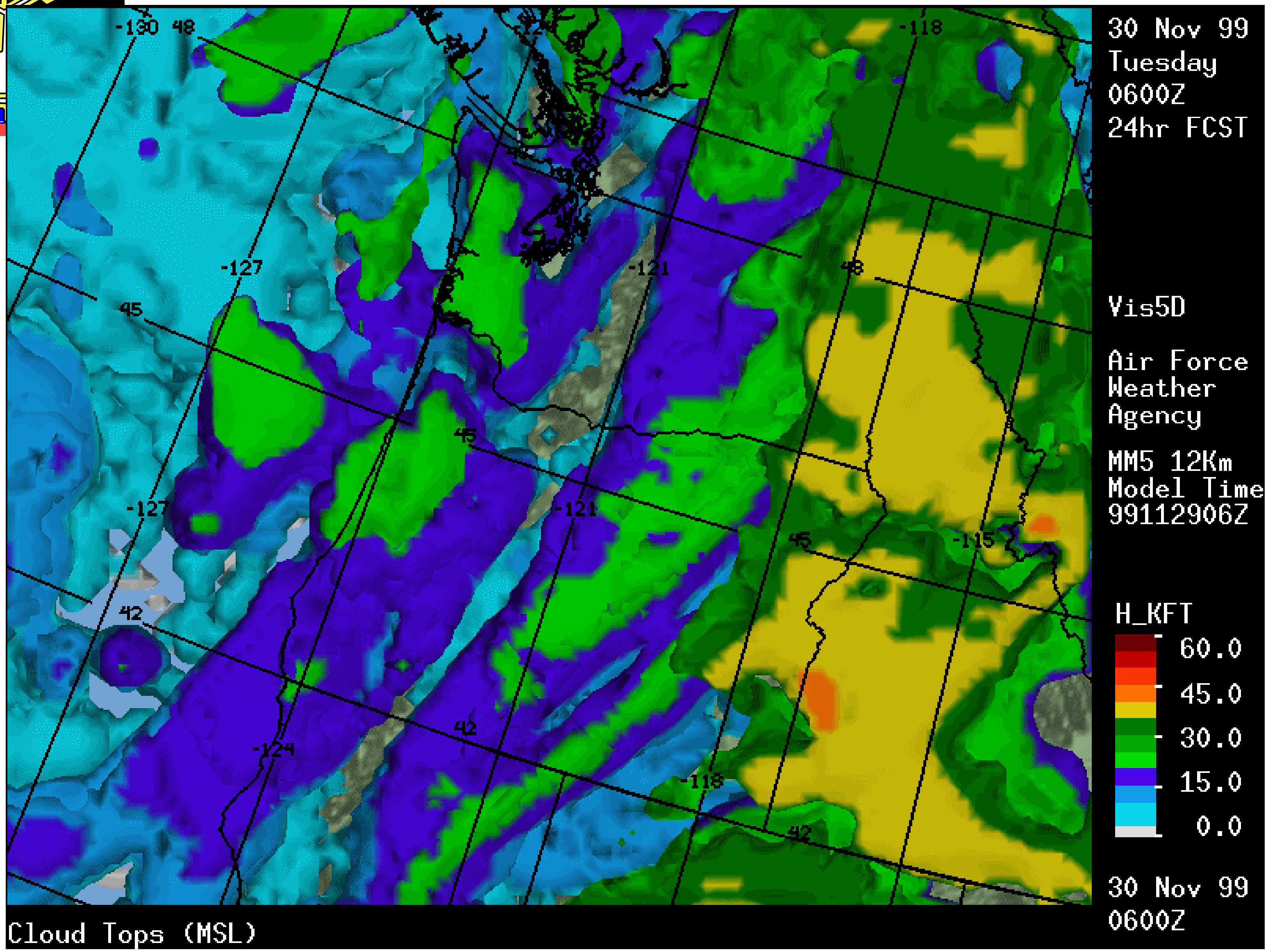
MM5 36km Cloud Tops/Surface Winds

72 Hr Forecast Valid 2 Dec 06Z



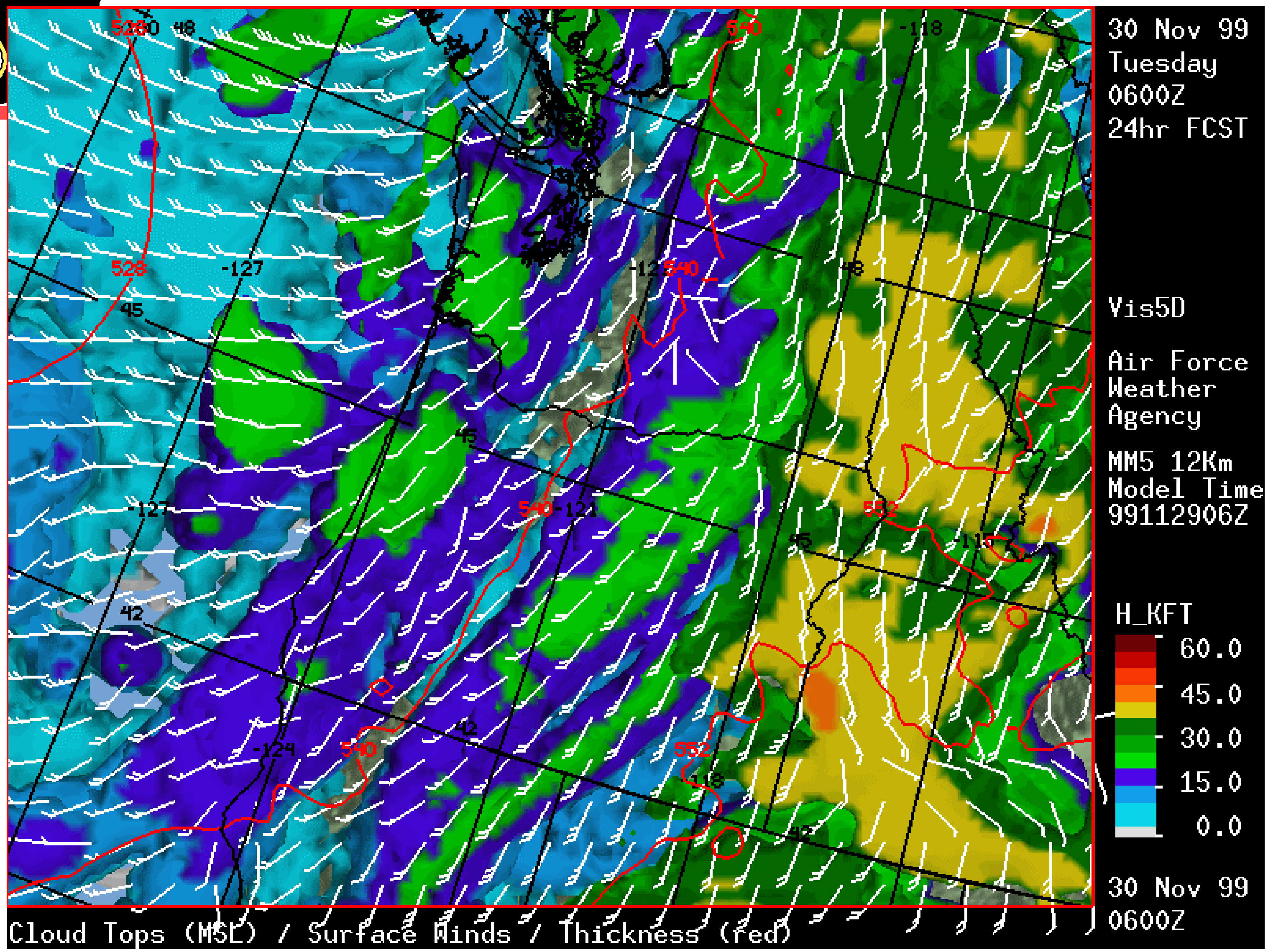
MM5 12km Cloud Tops Image

24 Hr Forecast Valid 30 Nov 06Z



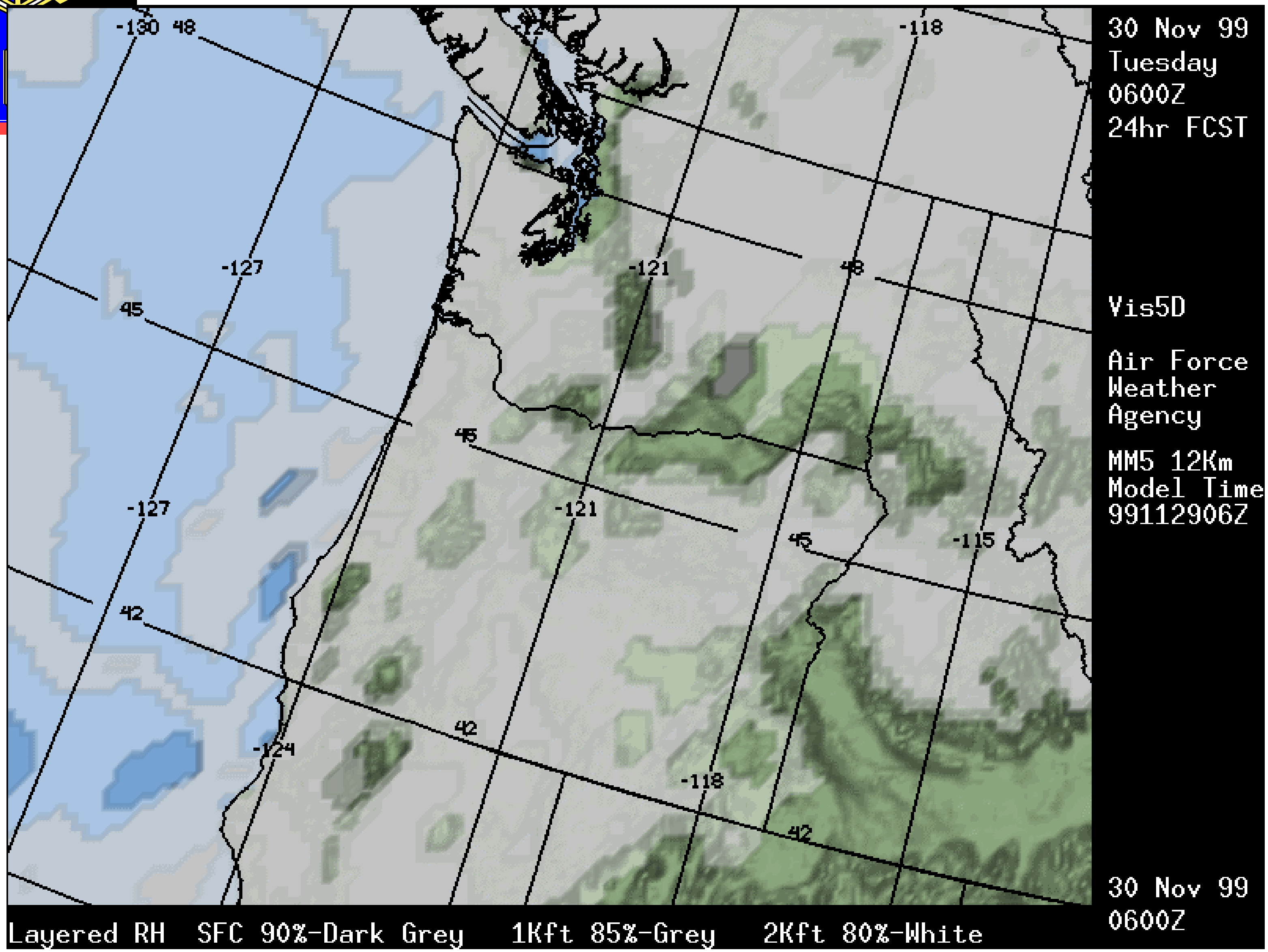
MM5 12km Cloud Tops/Surface Winds

24 Hr Forecast Valid 30 Nov 06Z



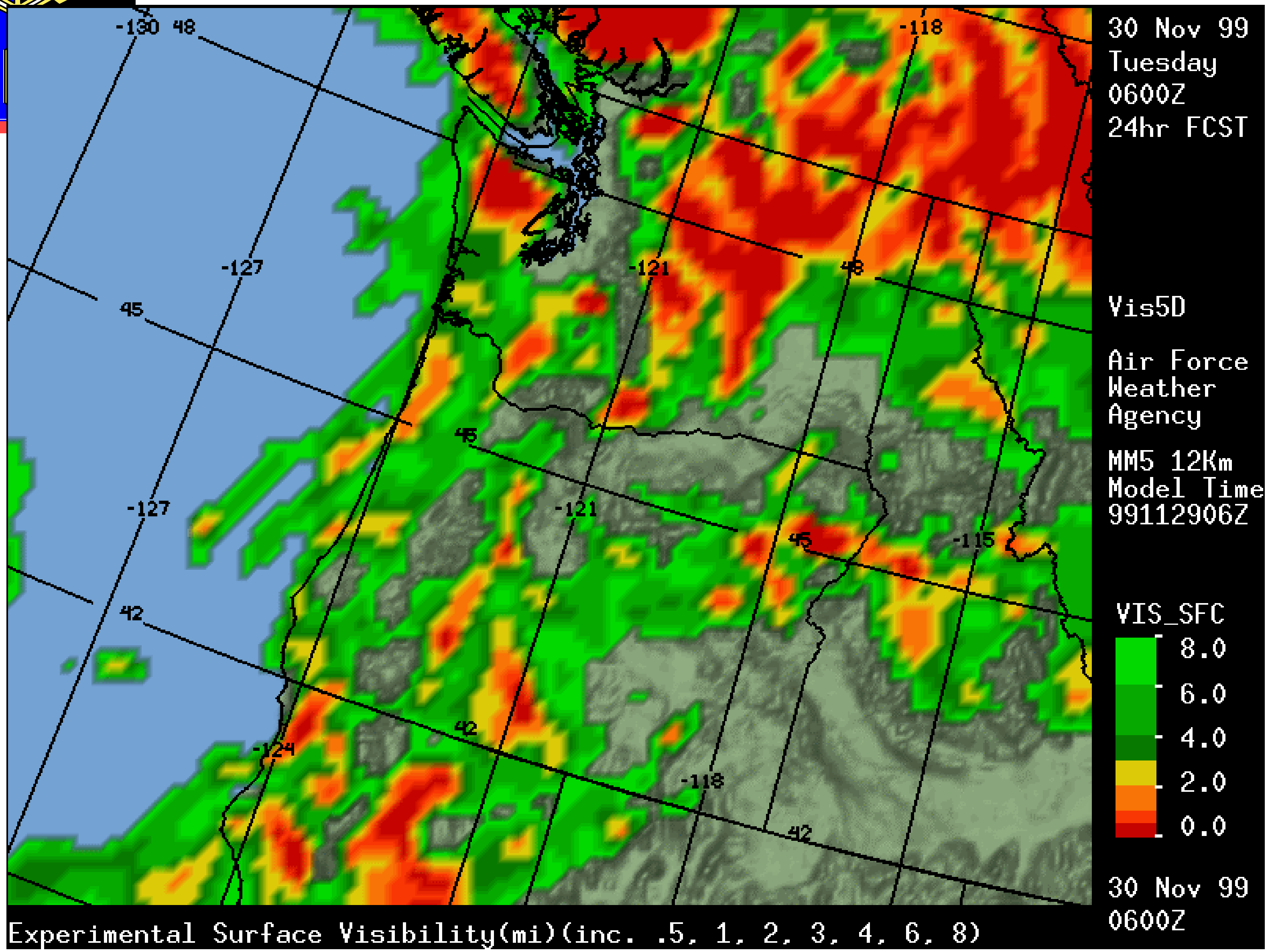
MM5 12km Low Clouds and Fog

24 Hr Forecast Valid 30 Nov 06Z



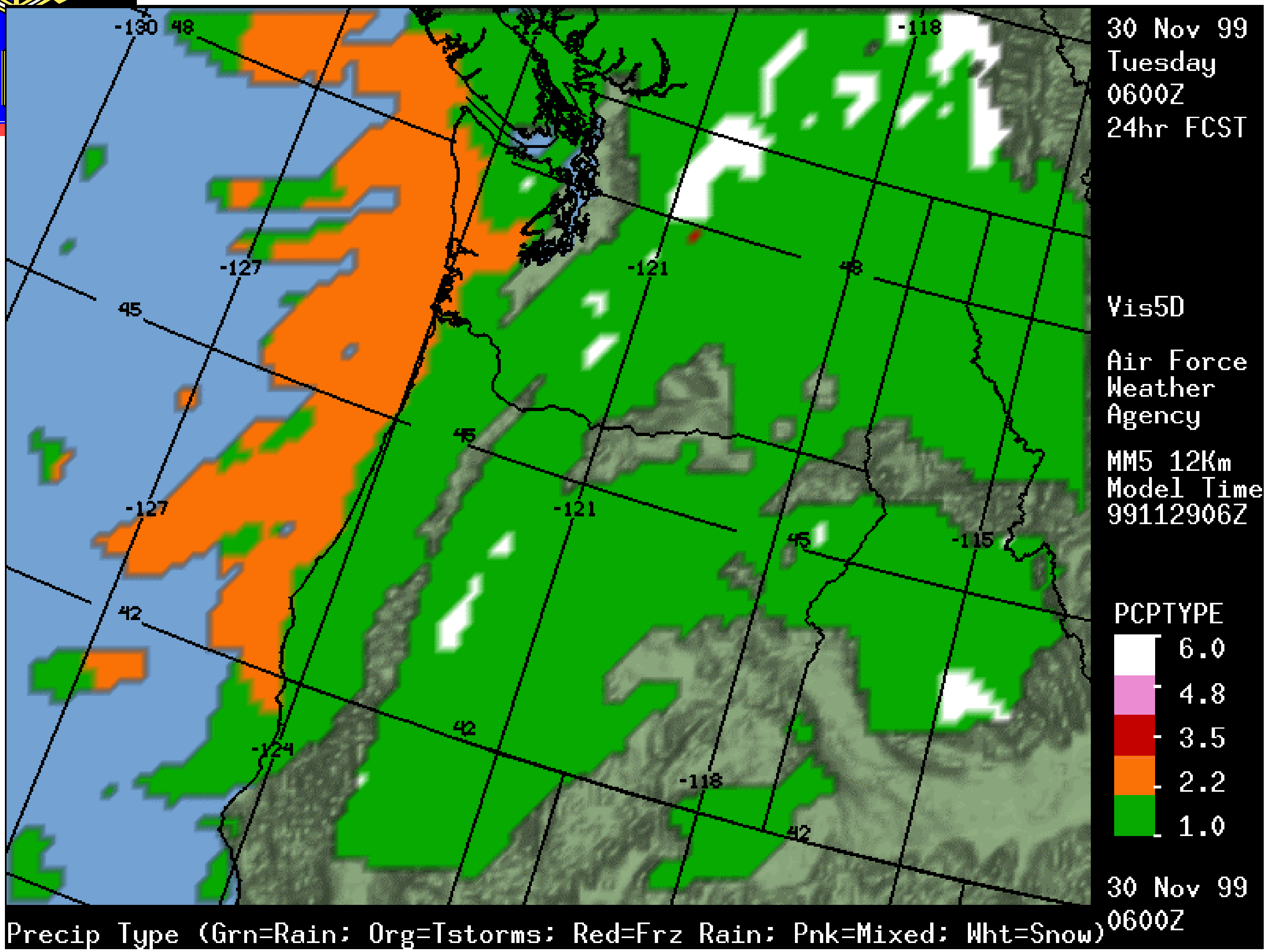
MM5 12km Surface Visibility

24 Hr Forecast Valid 30 Nov 06Z



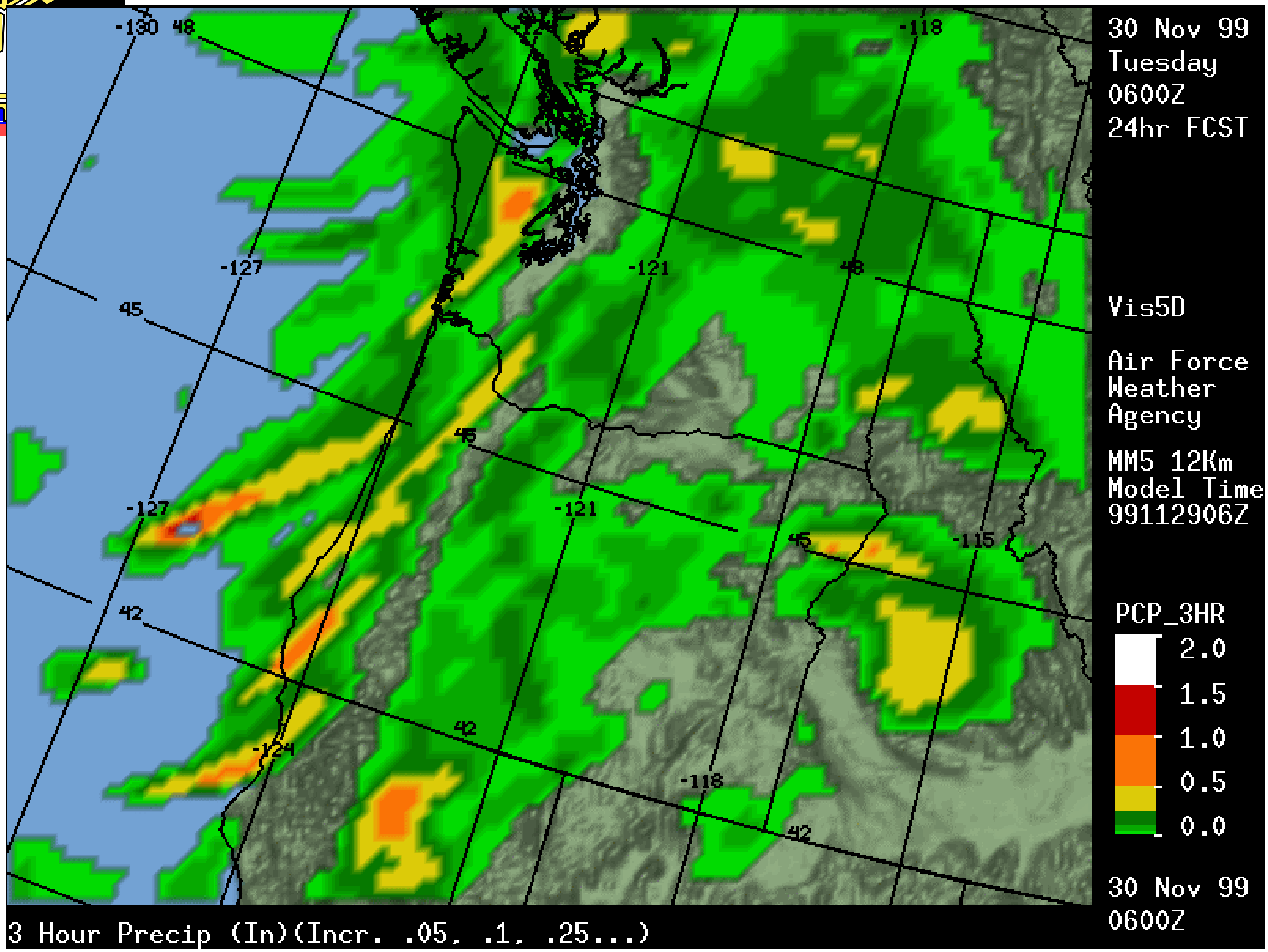
MM5 12km Precipitation Type

24 Hr Forecast Valid 30 Nov 06Z



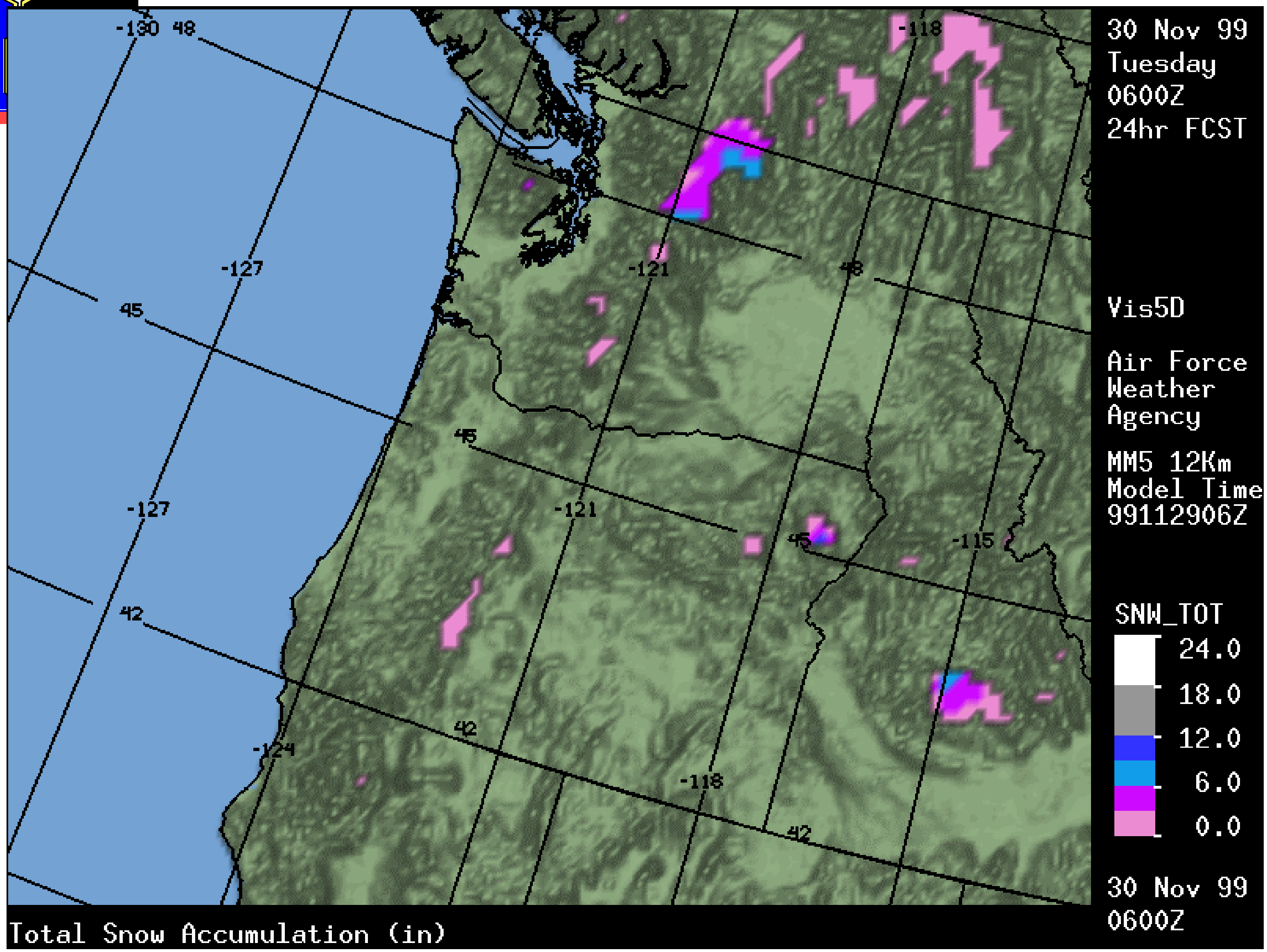
MM5 12km 3 Hr Precip Accumulation

24 Hr Forecast Valid 30 Nov 06Z



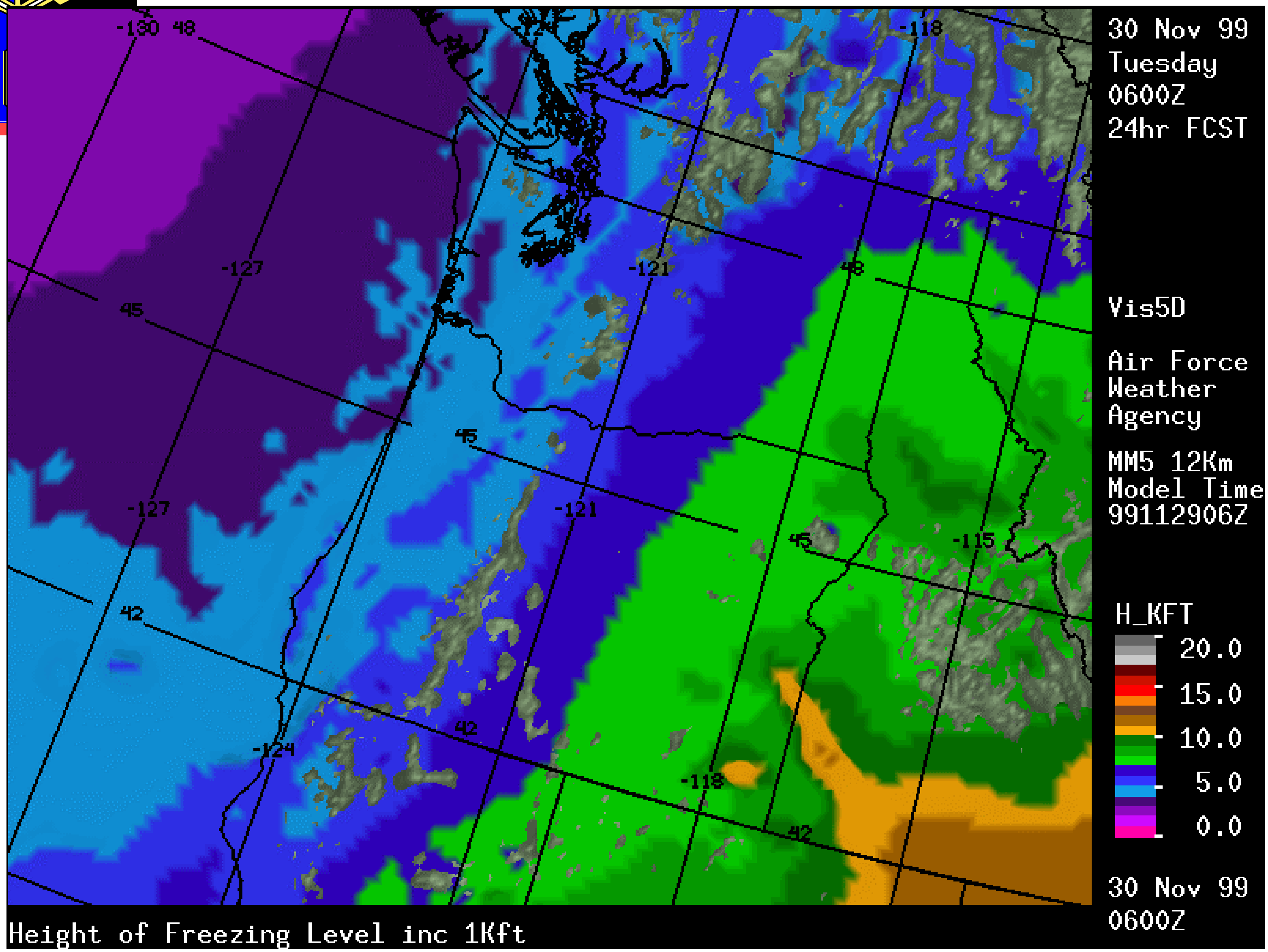
MM5 12km Total Snow Accumulation

24 Hr Forecast Valid 30 Nov 06Z



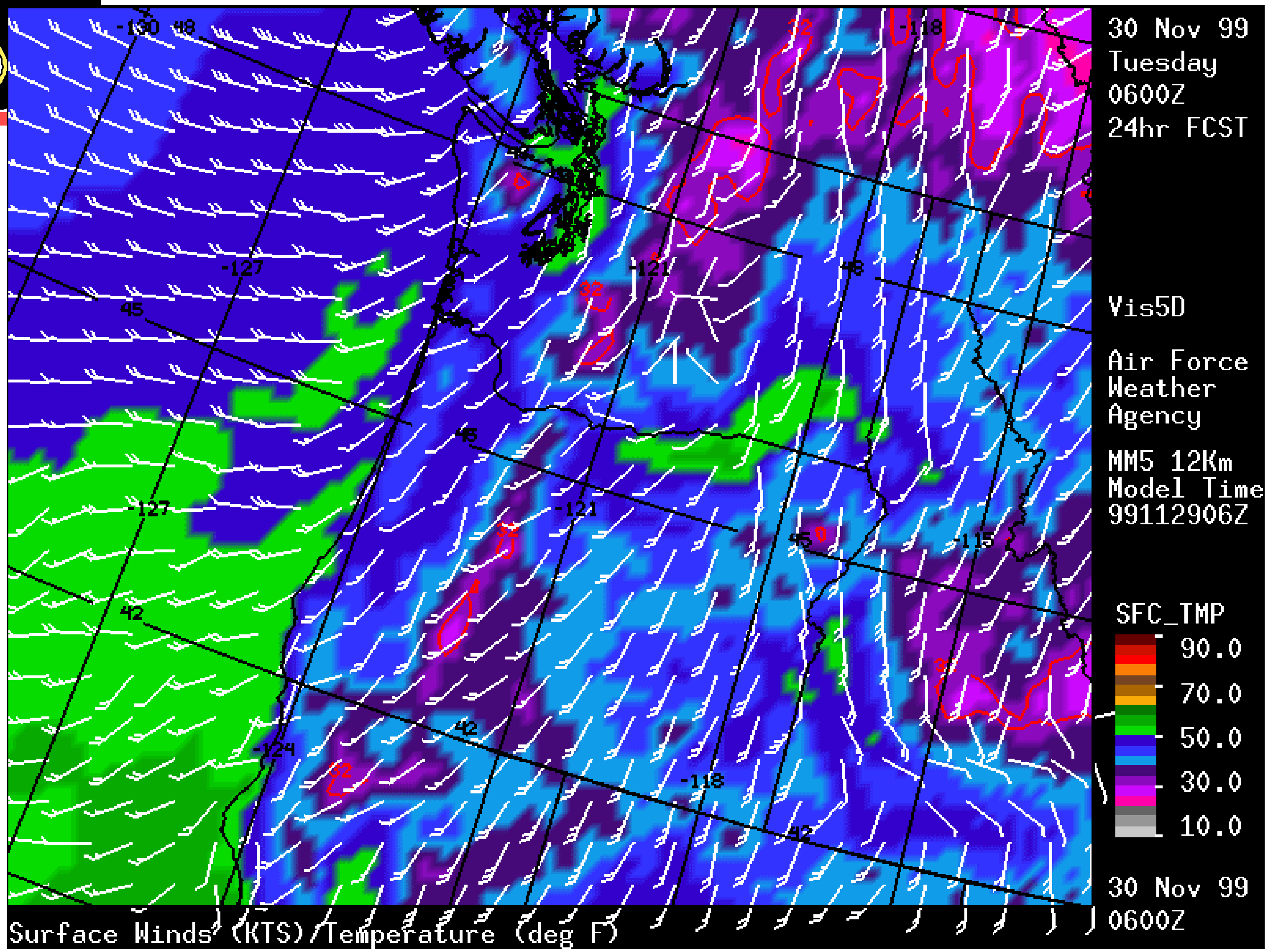
MM5 12km Height of Freezing Level

24 Hr Forecast Valid 30 Nov 06Z



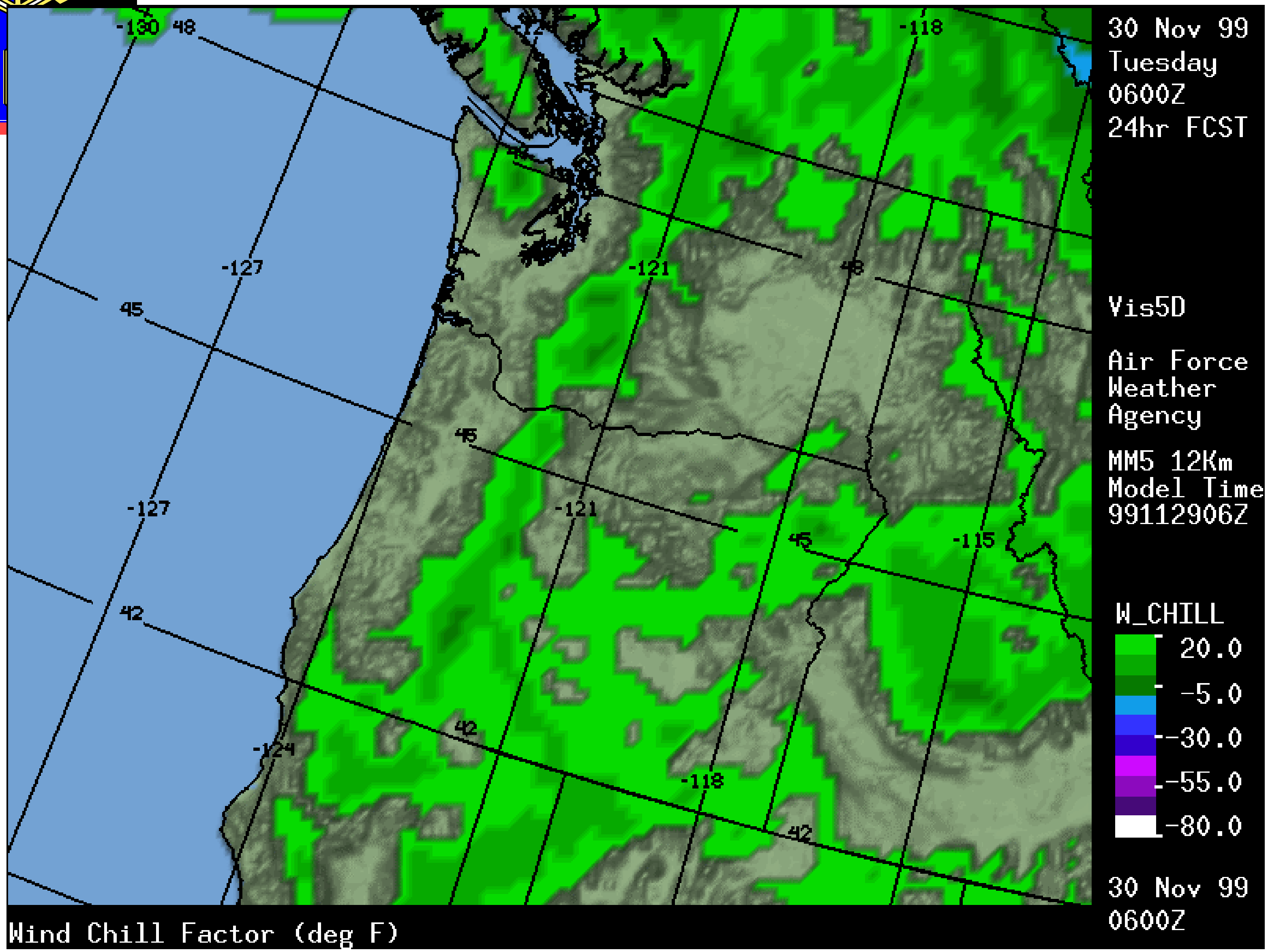
MM5 12km Surface Winds/Temperature

24 Hr Forecast Valid 30 Nov 06Z

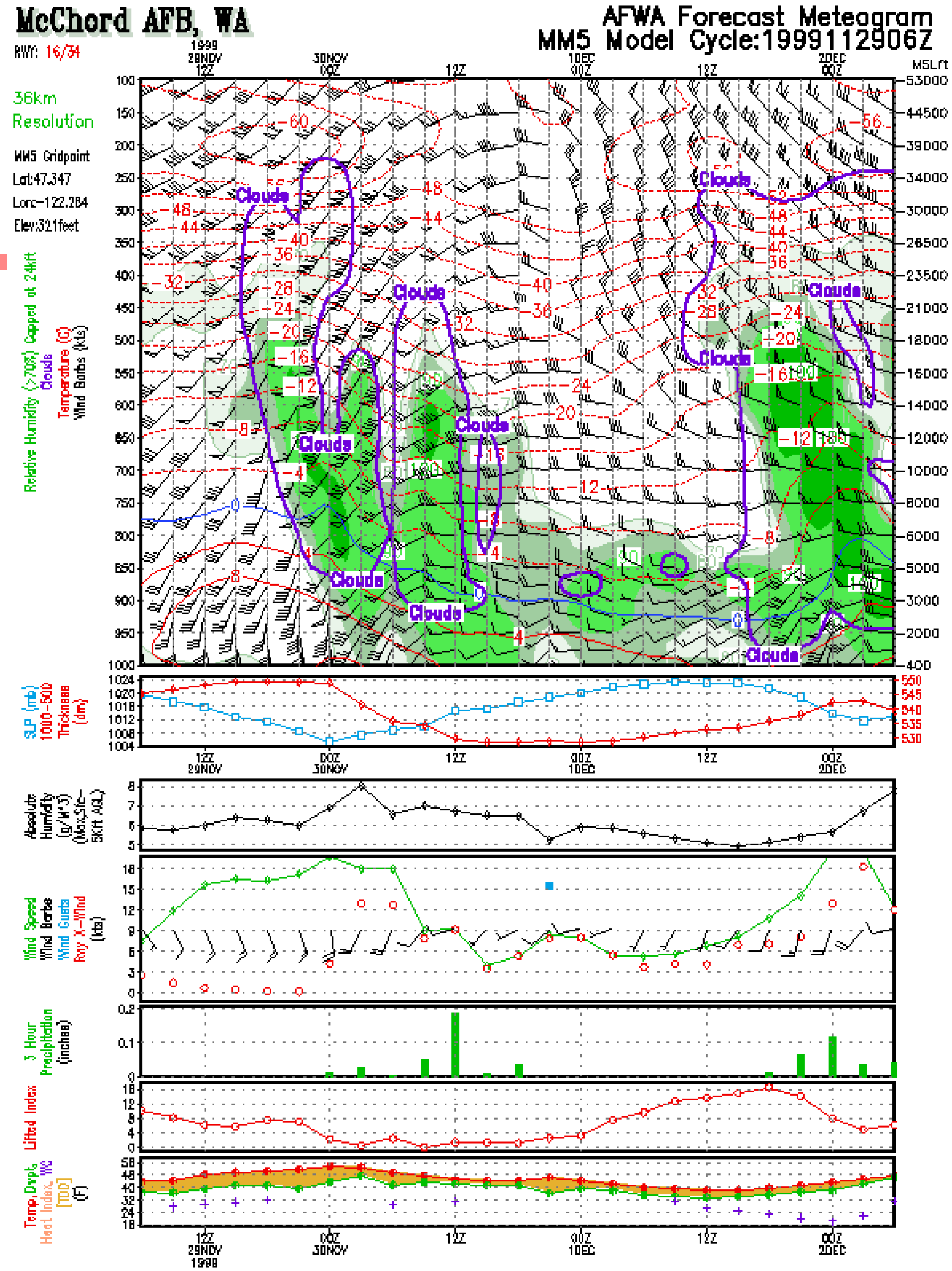


MM5 12km Wind Chill Factor

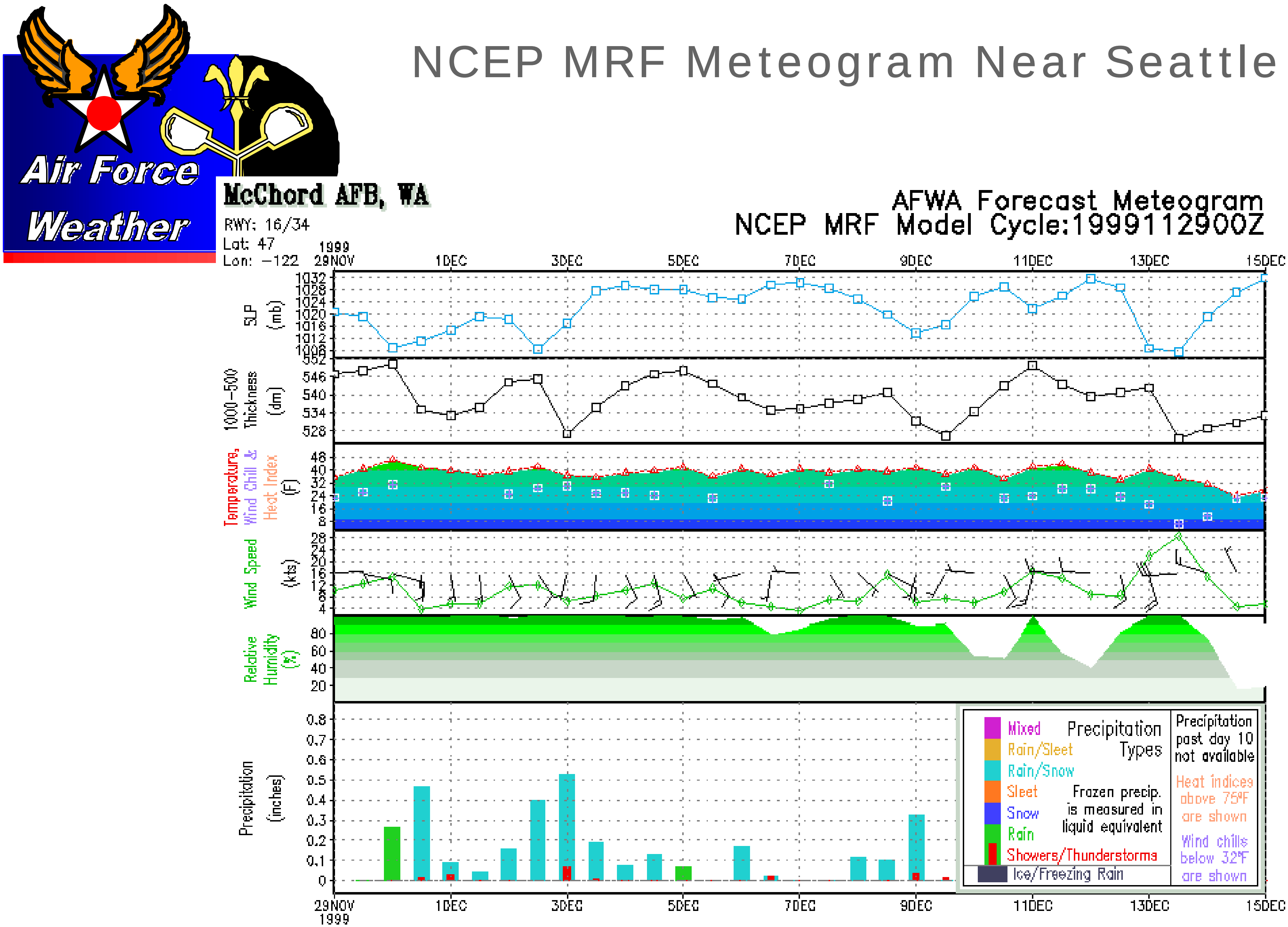
24 Hr Forecast Valid 30 Nov 06Z



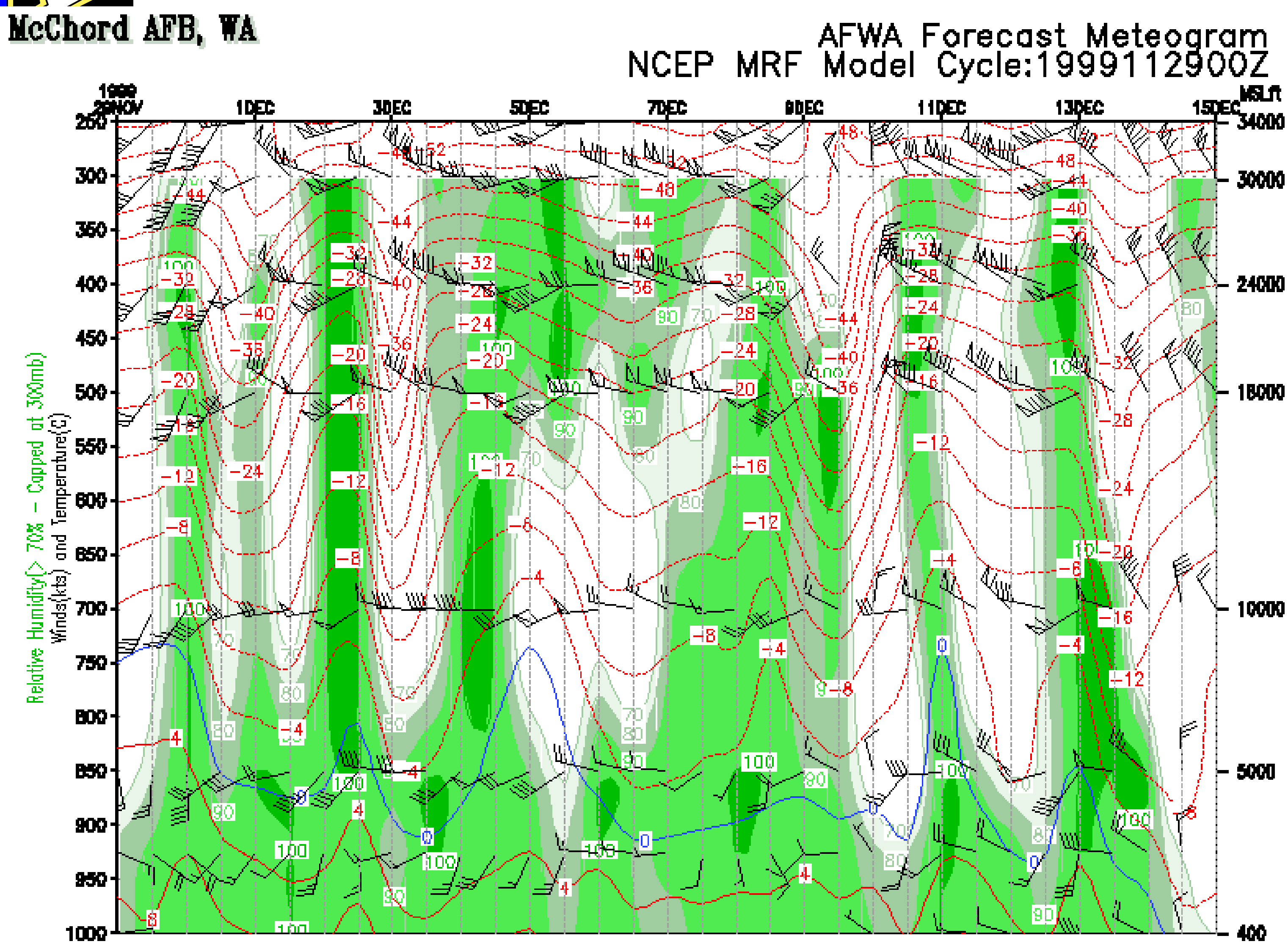
MM5 Meteogram Near Seattle



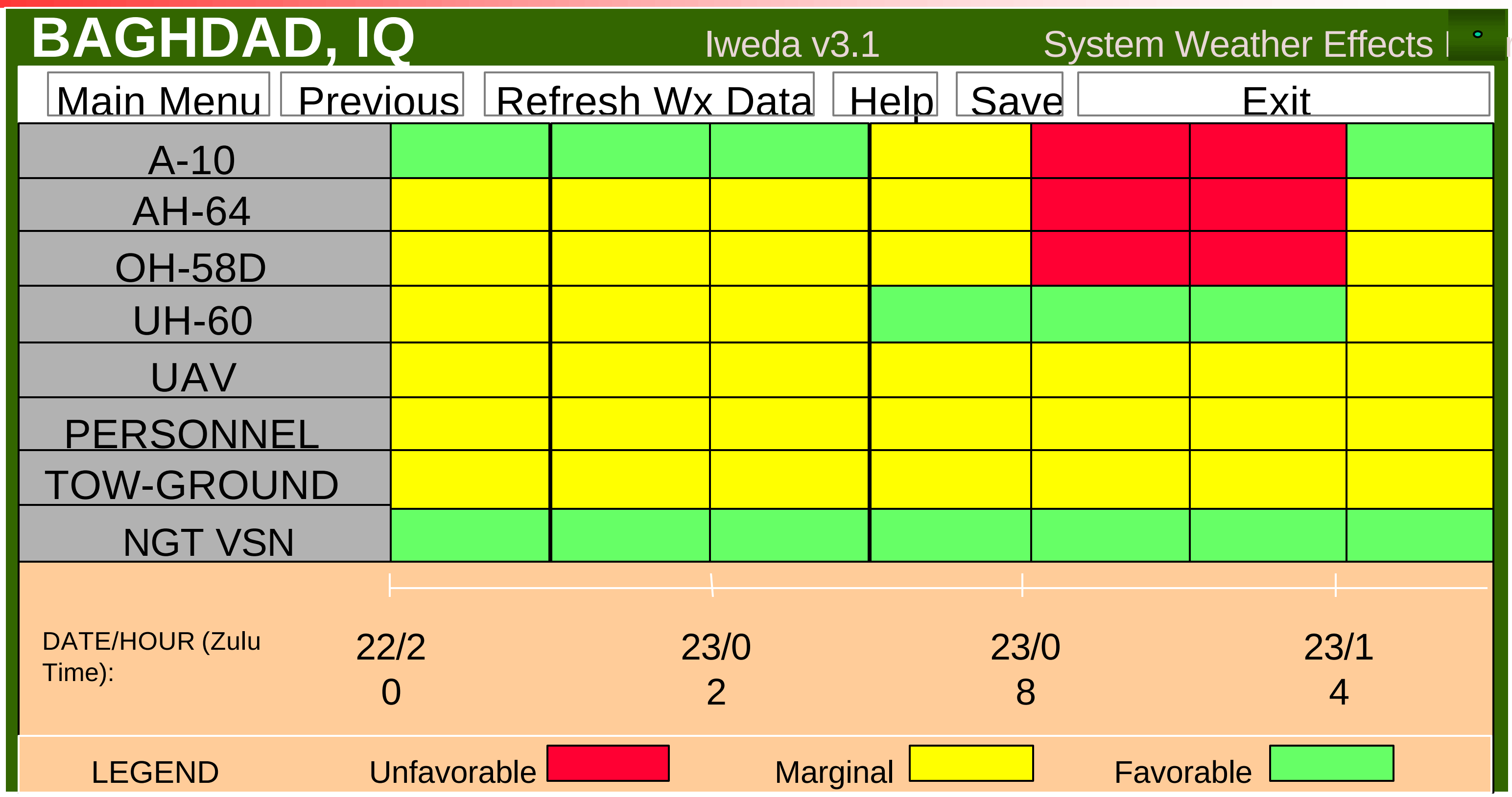
NCEP MRF Meteogram Near Seattle



MRF Upper Air Meteogram Near Seattle



TECHNOLOGIES:
Weather Effects Visualization
(Result of AF-Army Partnering)



IWEDA provides a stop-light representation of weather impacts on sensors, systems, platforms and operations at different times of the day based on critical value thresholds

WEATHER EFFECTS ON OPERATIONS

KOSOVO DAY 1

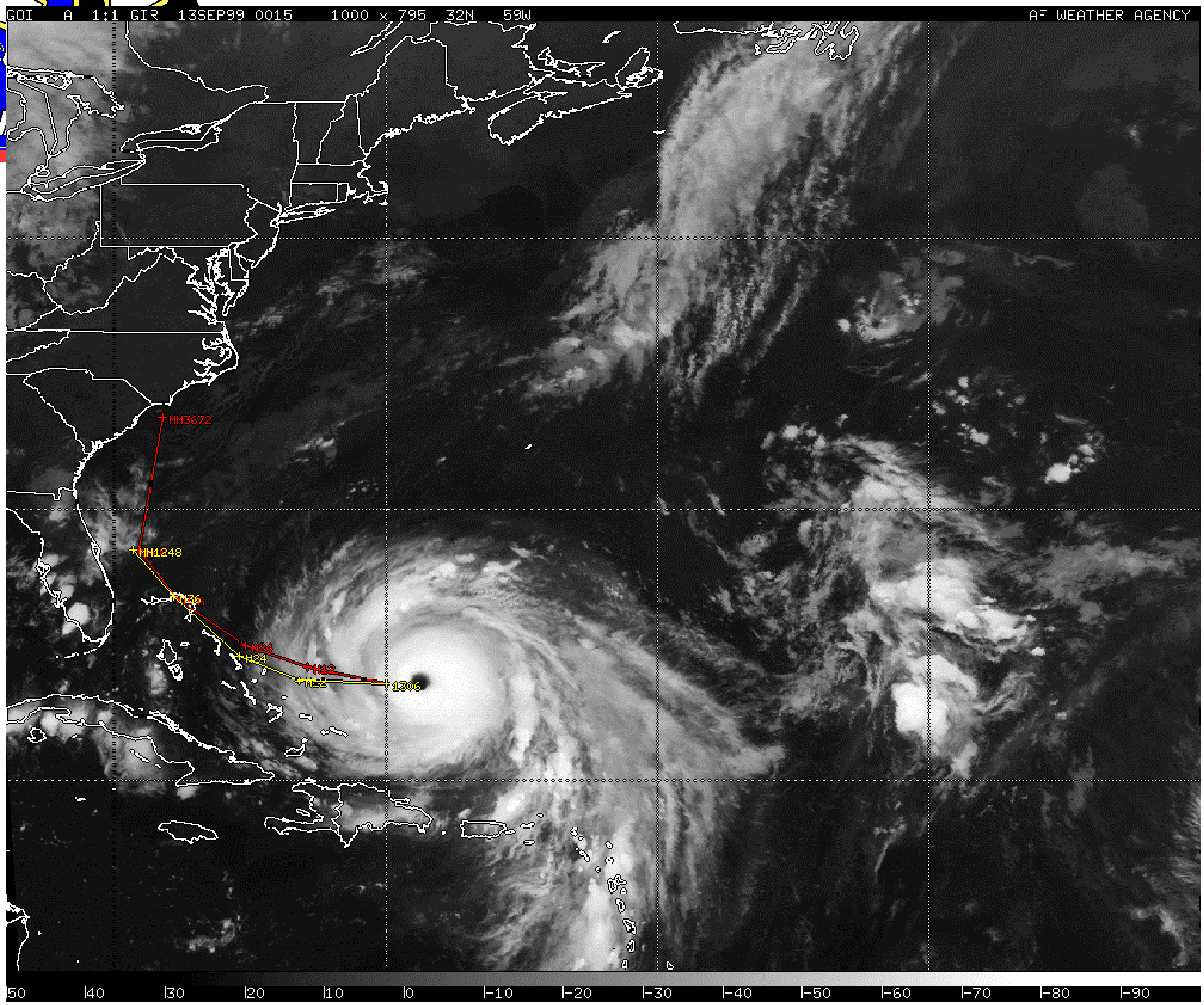
CREATED: 23 MAY 0200Z

23/02Z 08Z 14Z 20Z 24/02Z

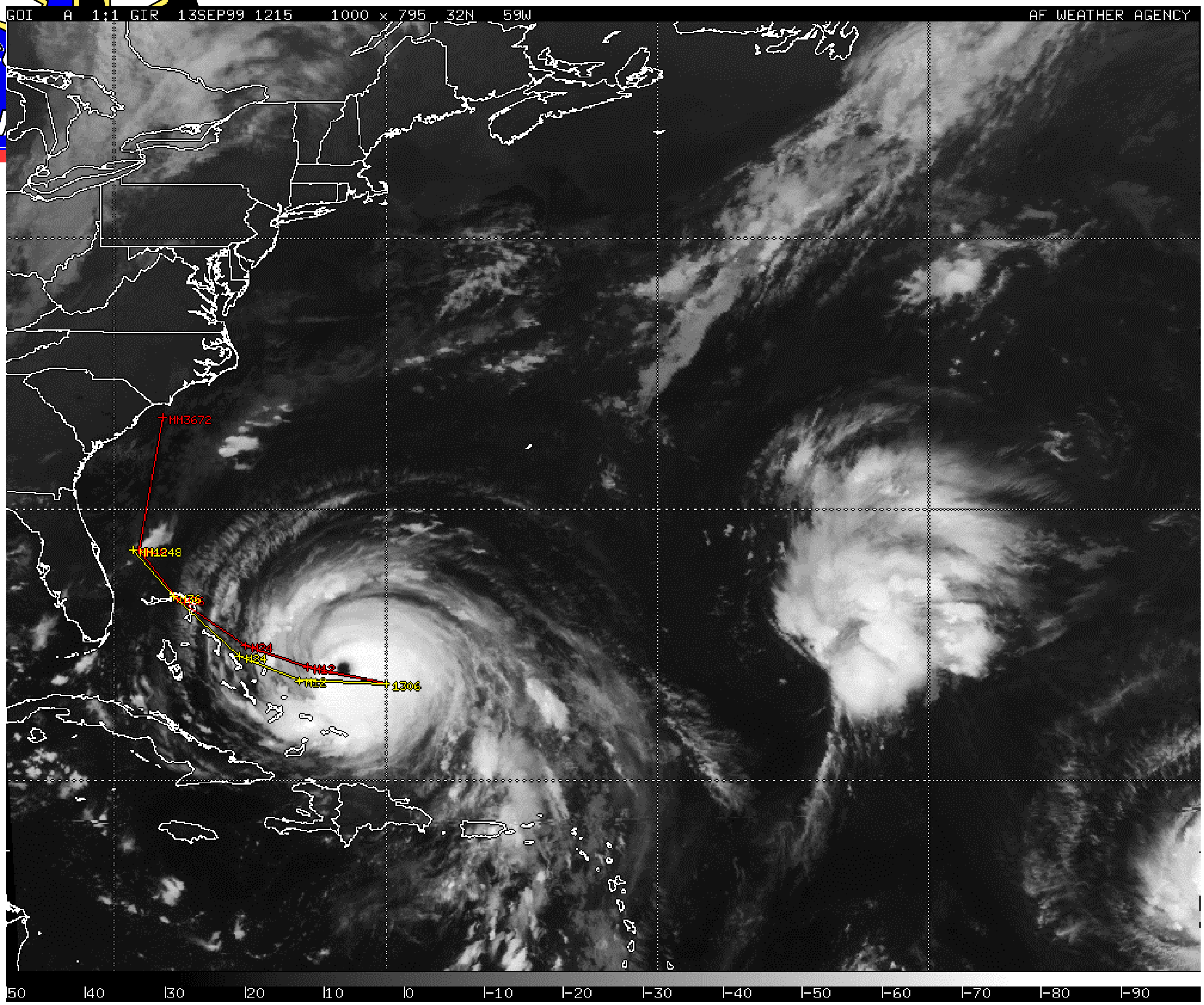
STRATRECCE	F	F	F	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
				CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG
HI TACRECCE	F	F	F	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
				CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG
LO TACRECCE	M	M	M	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
	VIS	VIS	VIS	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG
CAS	F	F	F	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
				CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG
HELO OPS	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
TAC AIRLIFT	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
PERSONNEL	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
GROUND OPS	F	F	F	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	U	U	U	U	U	U
				GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND
PGMs	F	F	F	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
				CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG	CIG

FAVORABLE MARGINAL UNFAVORABLE

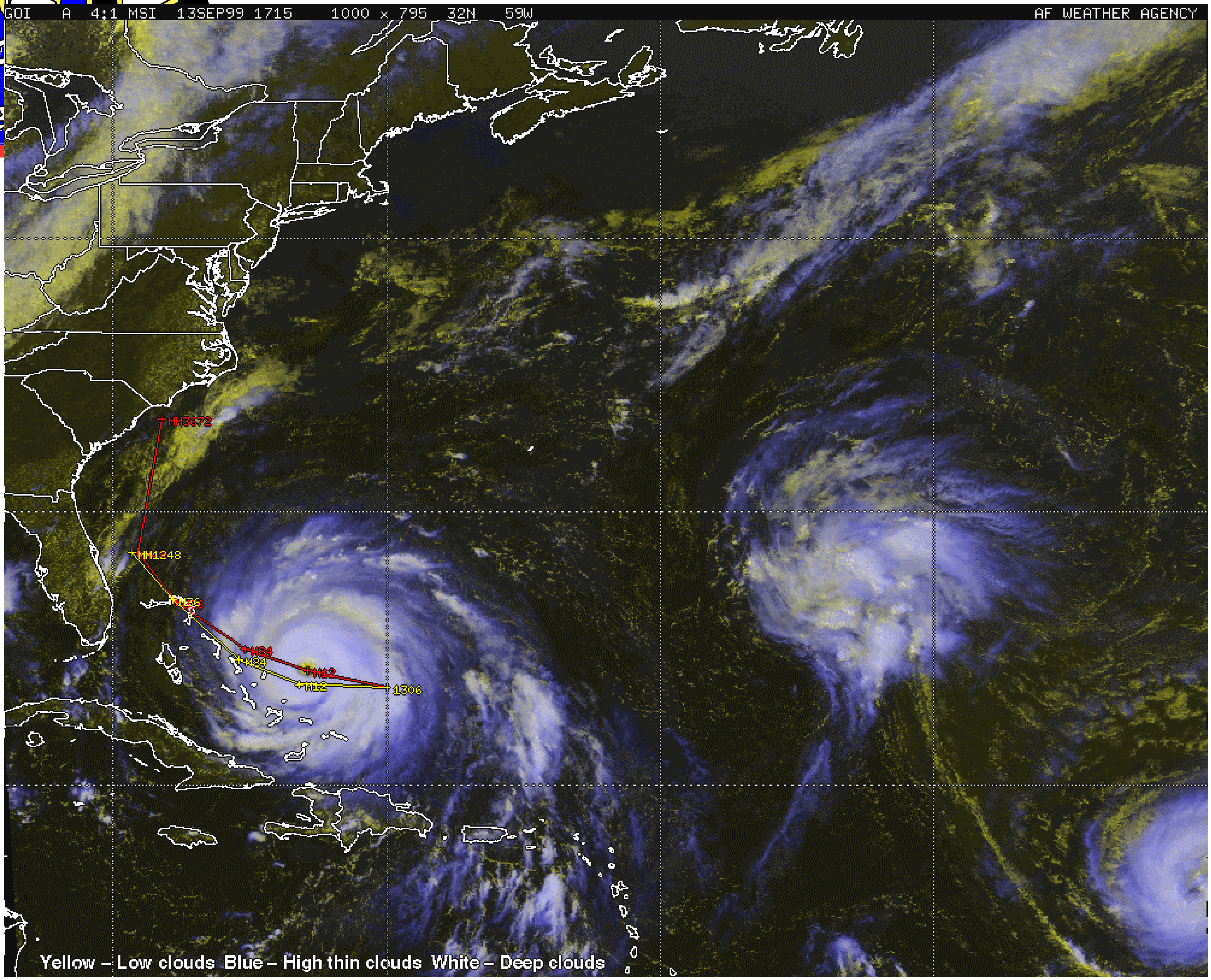
Hurricane Floyd - 13 September 1999, 0000Z



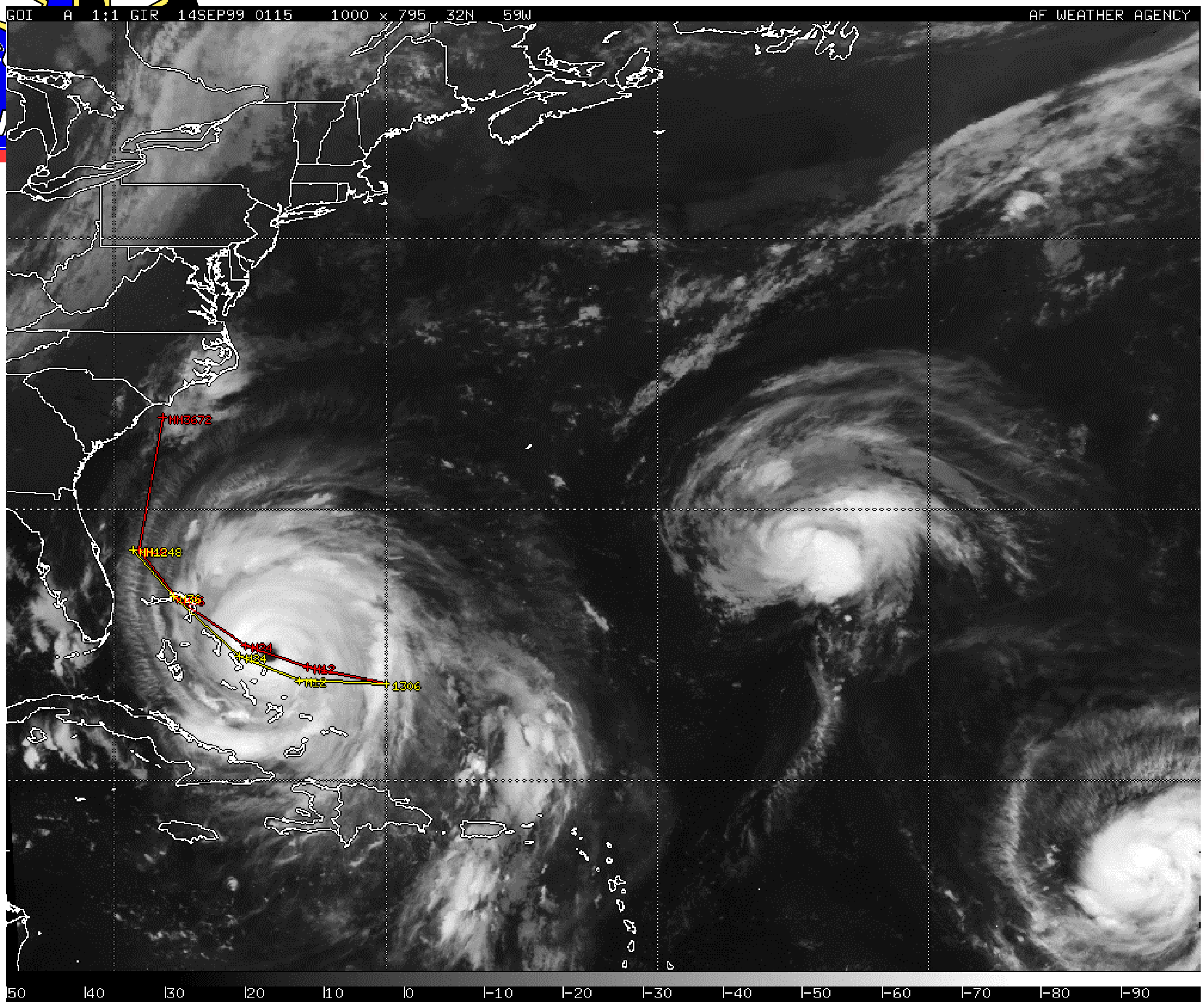
Hurricane Floyd - 13 September 1999, 1200Z



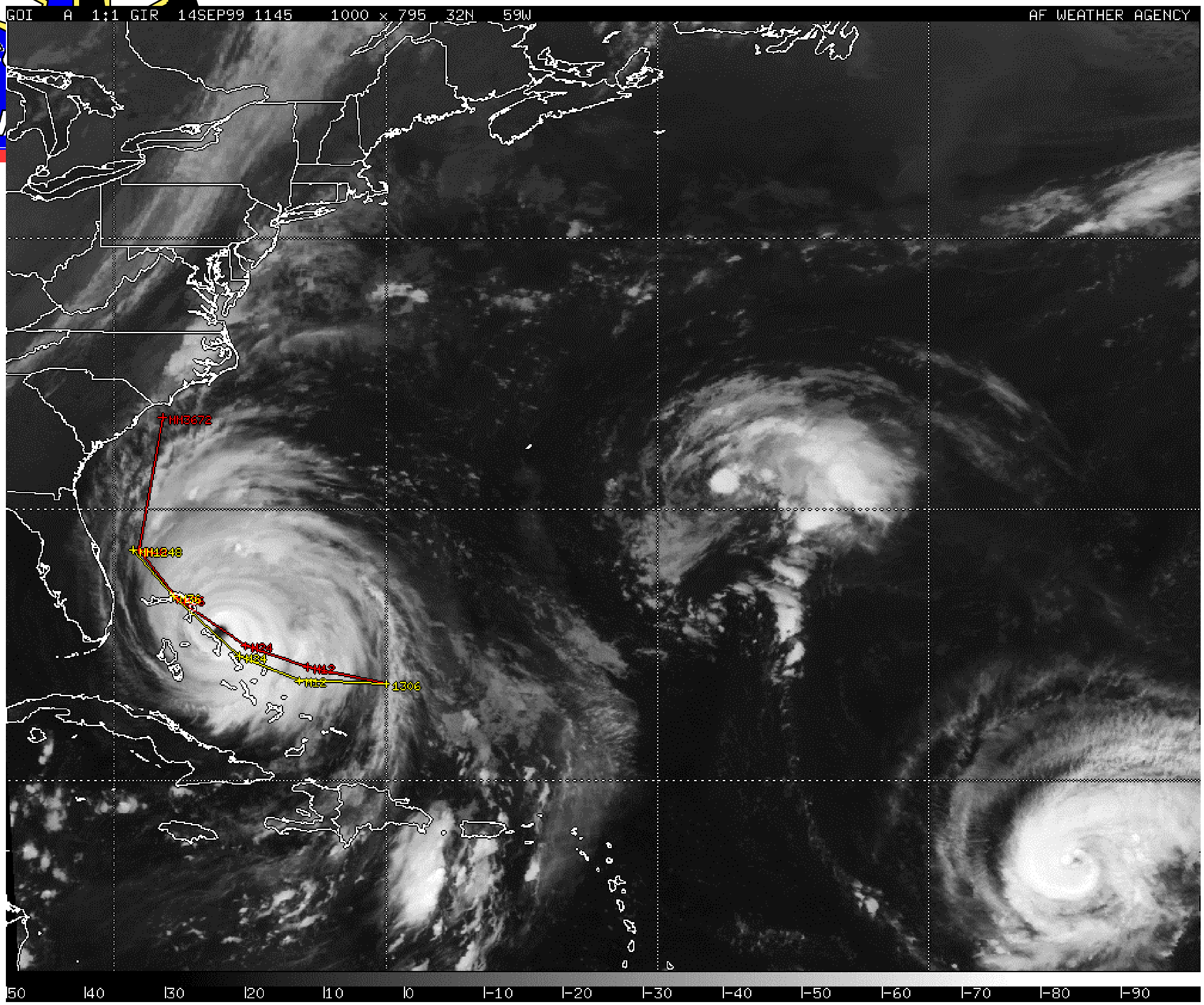
Hurricane Floyd - 13 September 1999, 1800Z



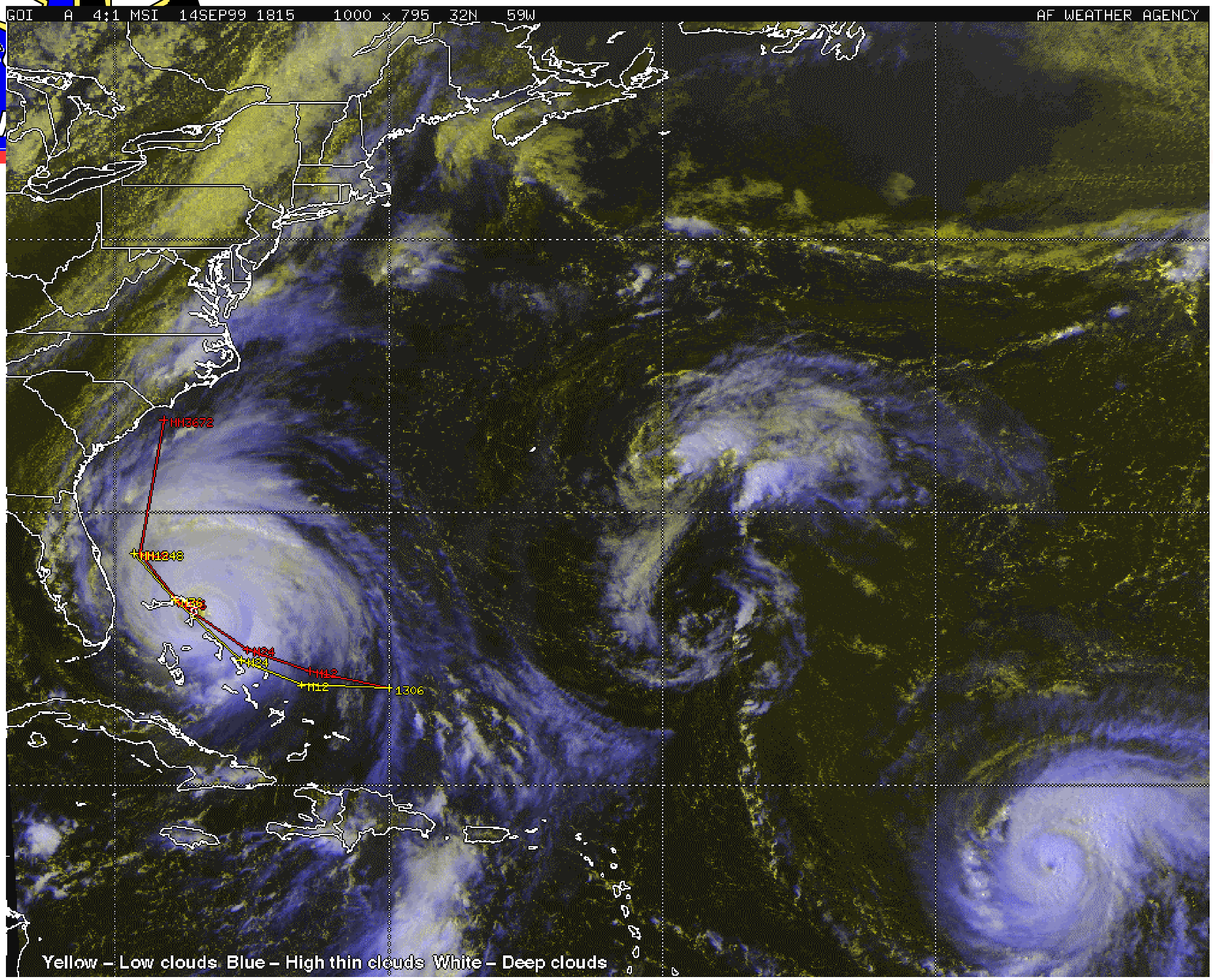
Hurricane Floyd - 14 September 1999, 0000Z



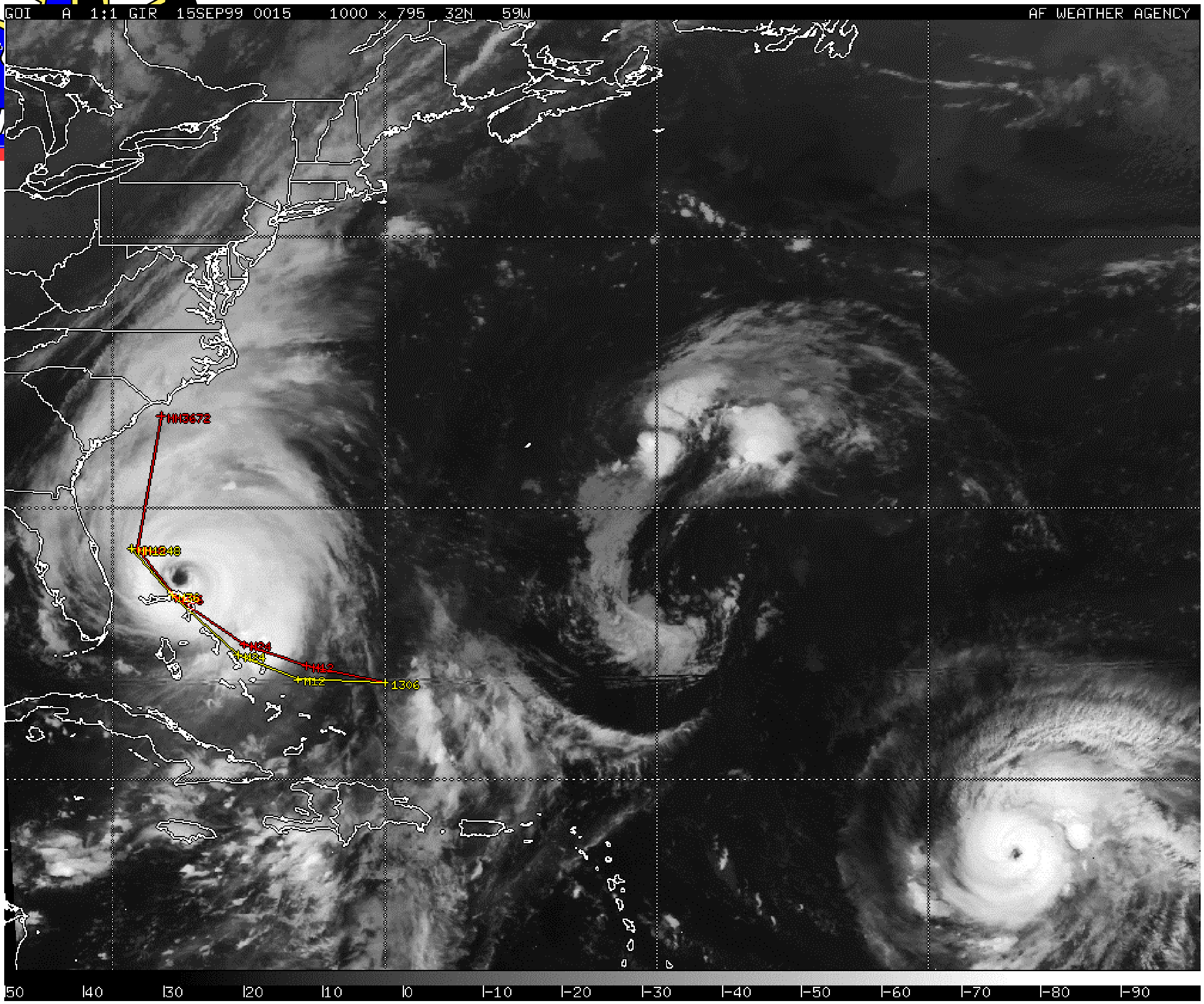
Hurricane Floyd - 14 September 1999, 1200Z



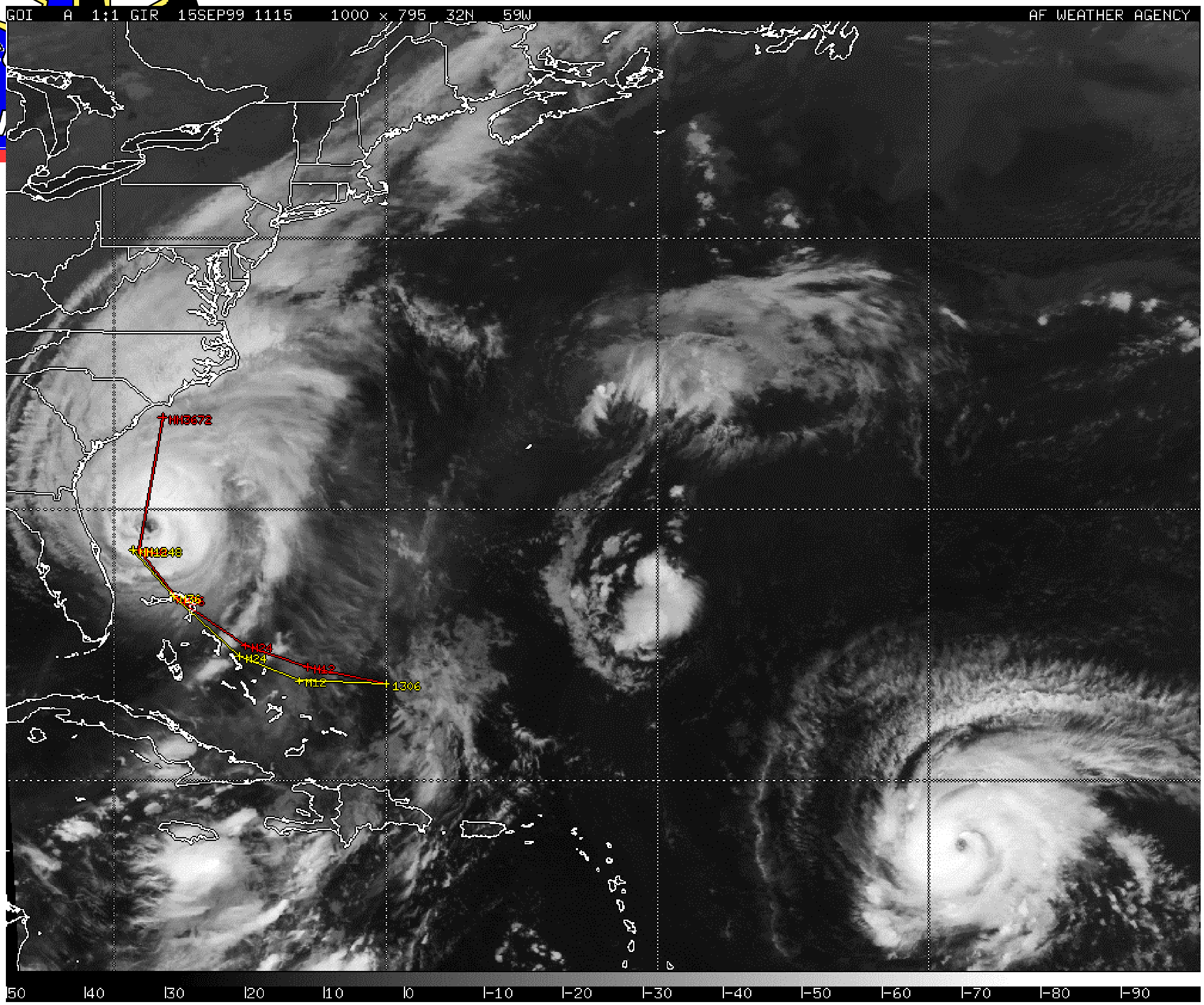
Hurricane Floyd - 14 September 1999, 1800Z



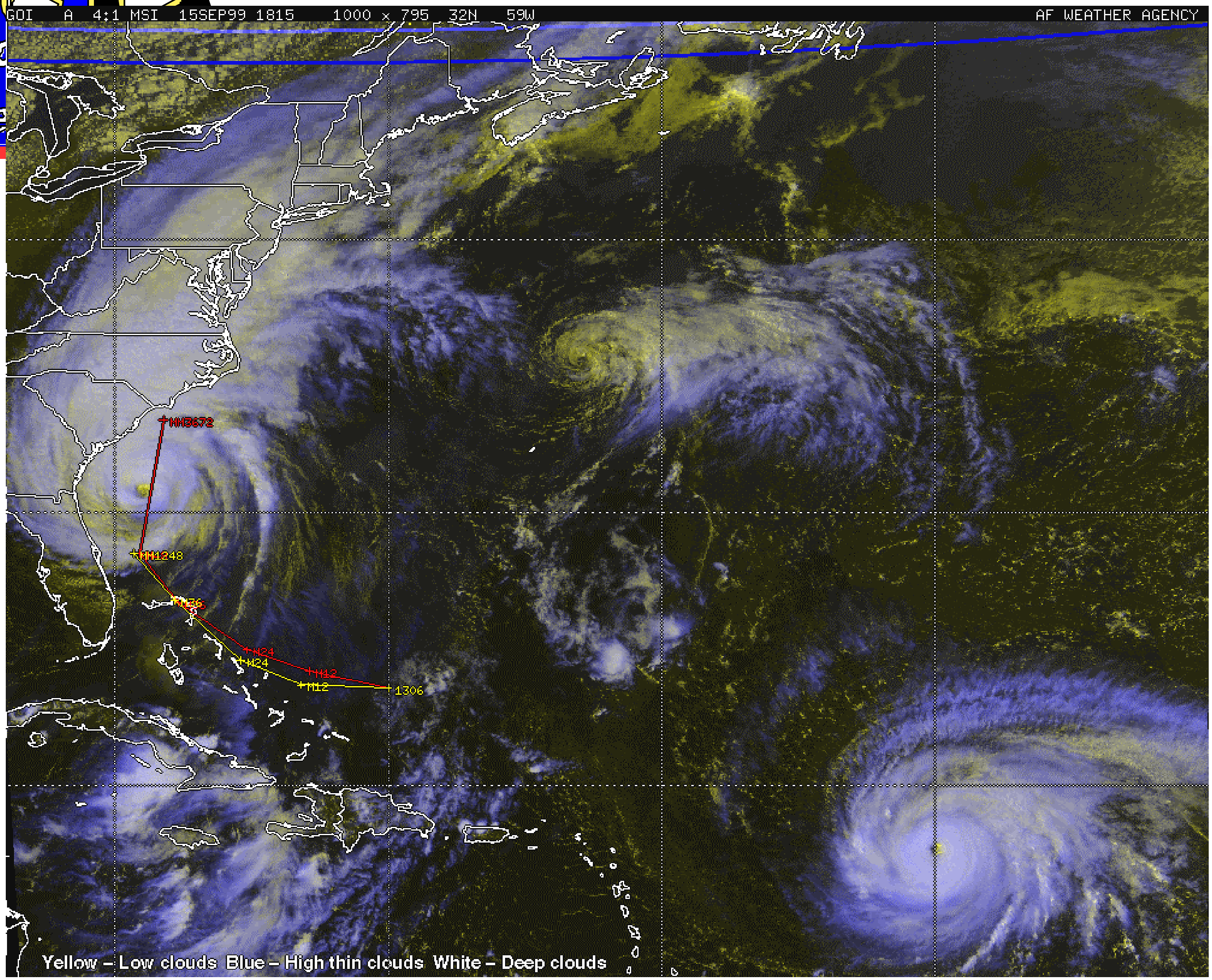
Hurricane Floyd - 15 September 1999, 0000Z



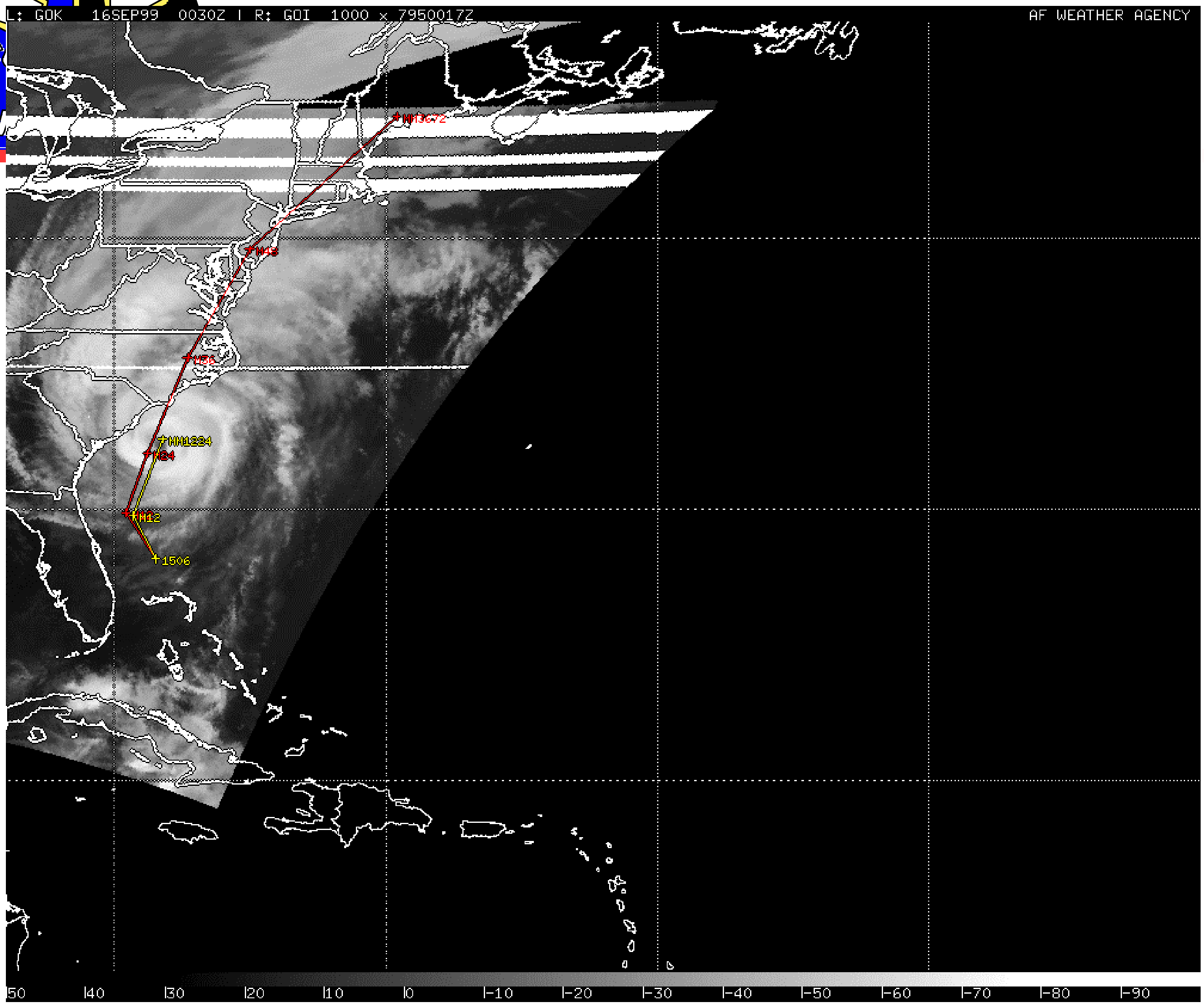
Hurricane Floyd - 15 September 1999, 1200Z



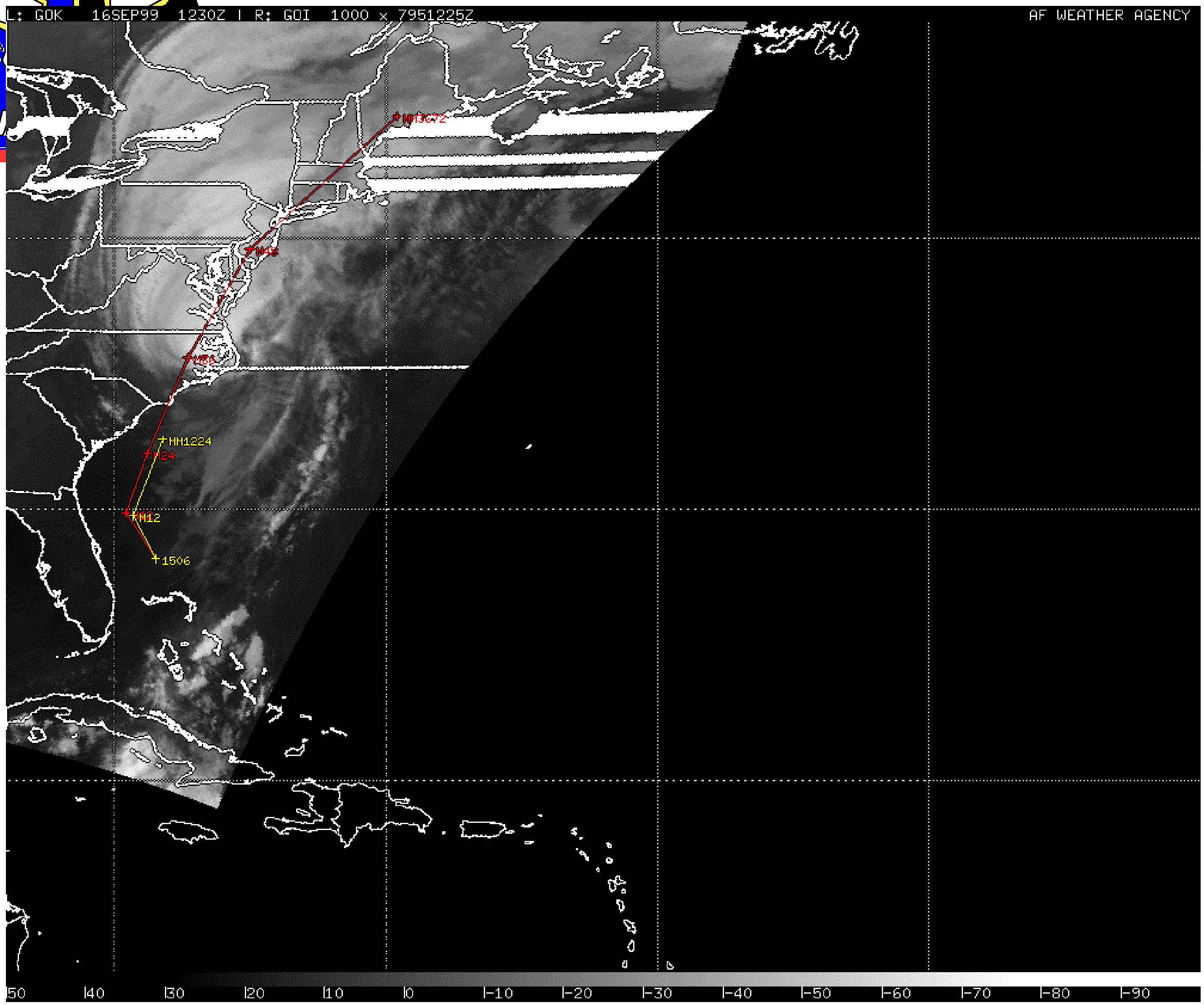
Hurricane Floyd - 15 September 1999, 1800Z



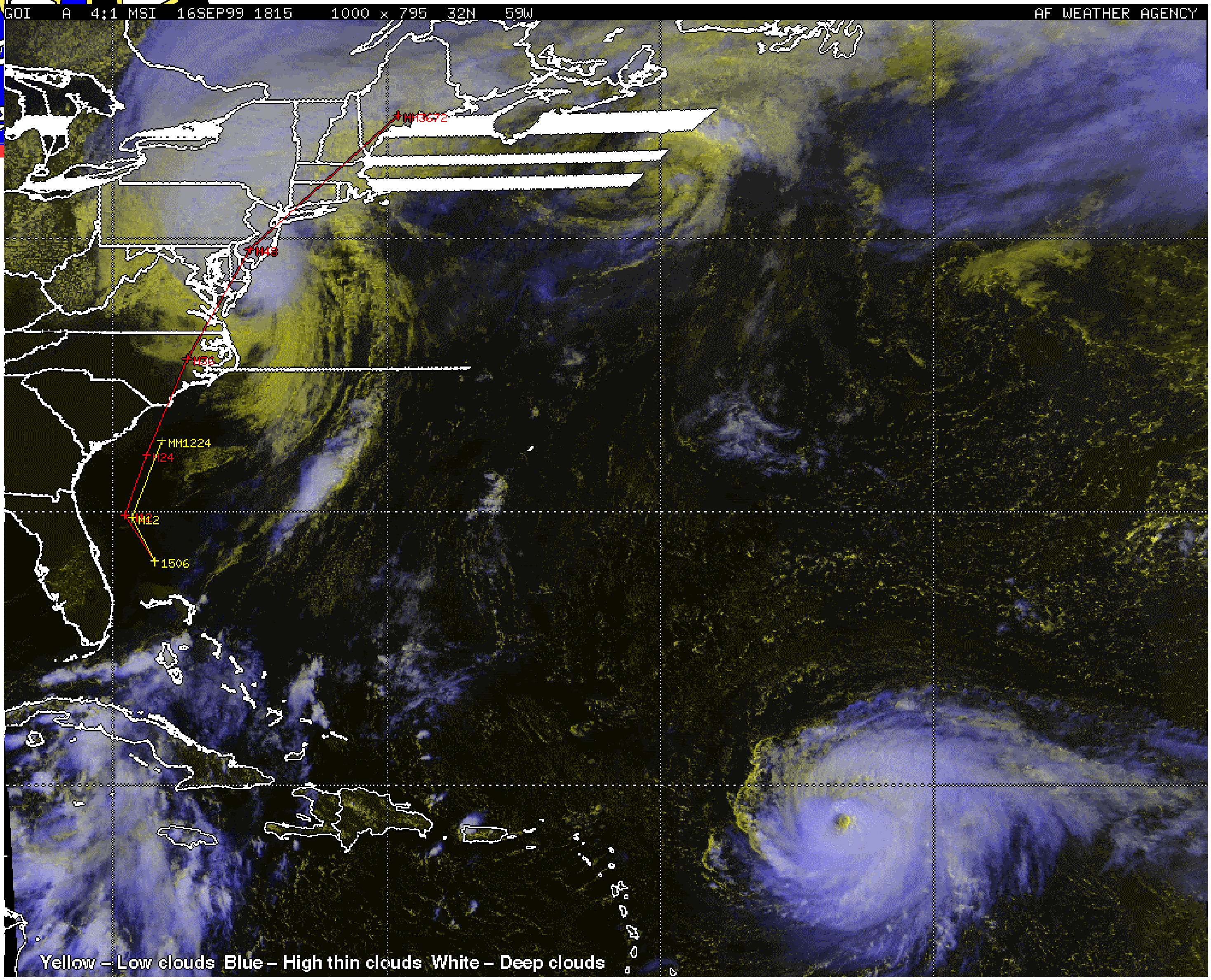
Hurricane Floyd - 16 September 1999, 0000Z



Hurricane Floyd - 16 September 1999, 1200Z

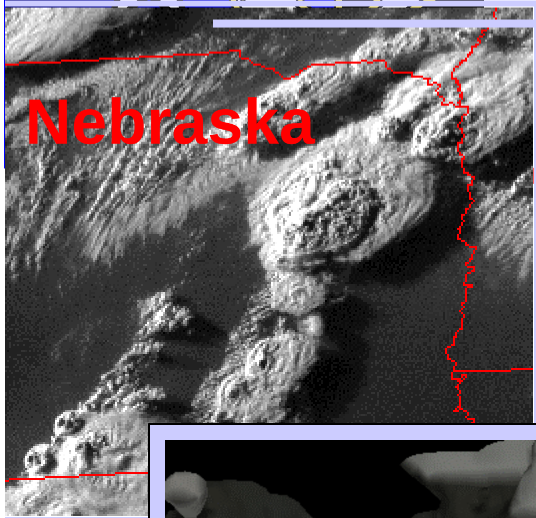


Hurricane Floyd - 16 September 1999, 1800Z

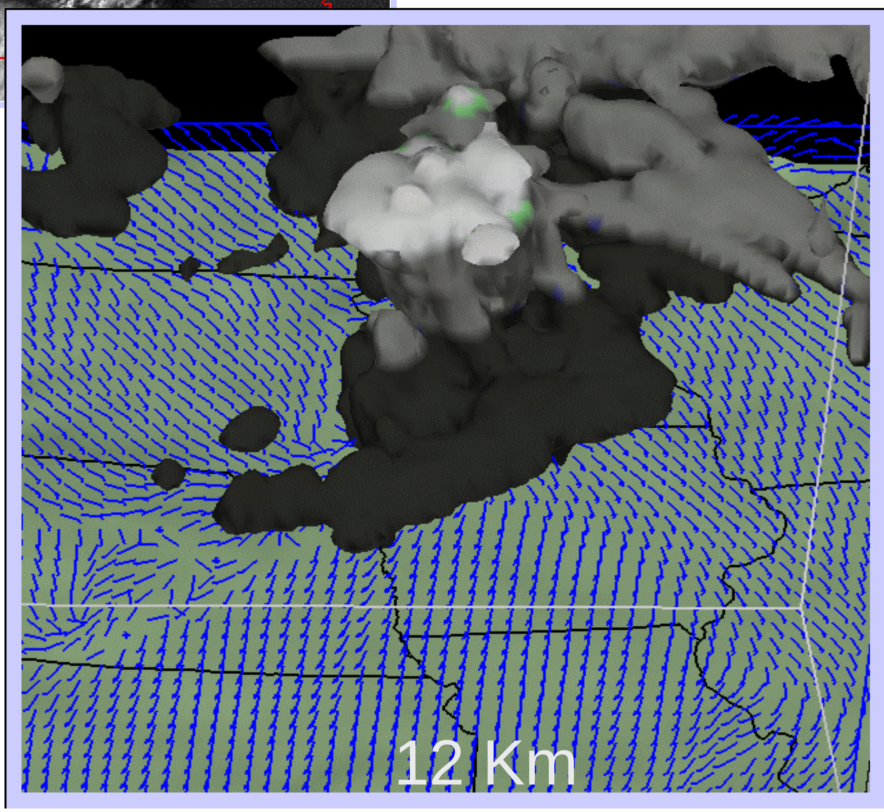


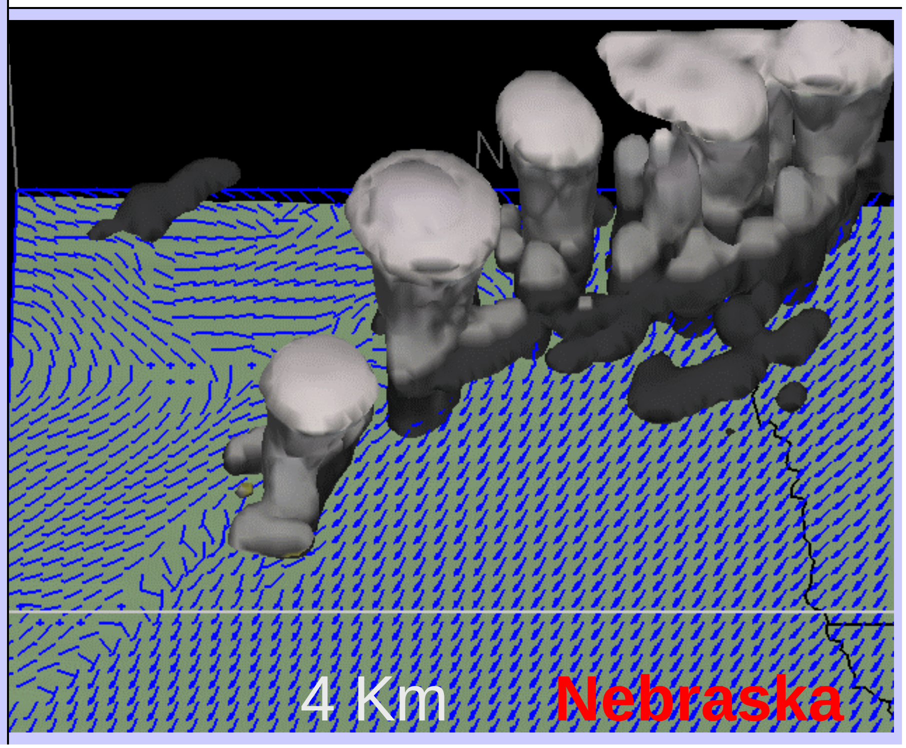
TECHNOLOGY

FINE-SCALE METSAT AND FORECASTING



Future of fine-scale weather forecasting is combining high-resolution satellite data with numerical weather prediction and producing visualizations with impact





SUMMARY

Weather and Surface Transportation

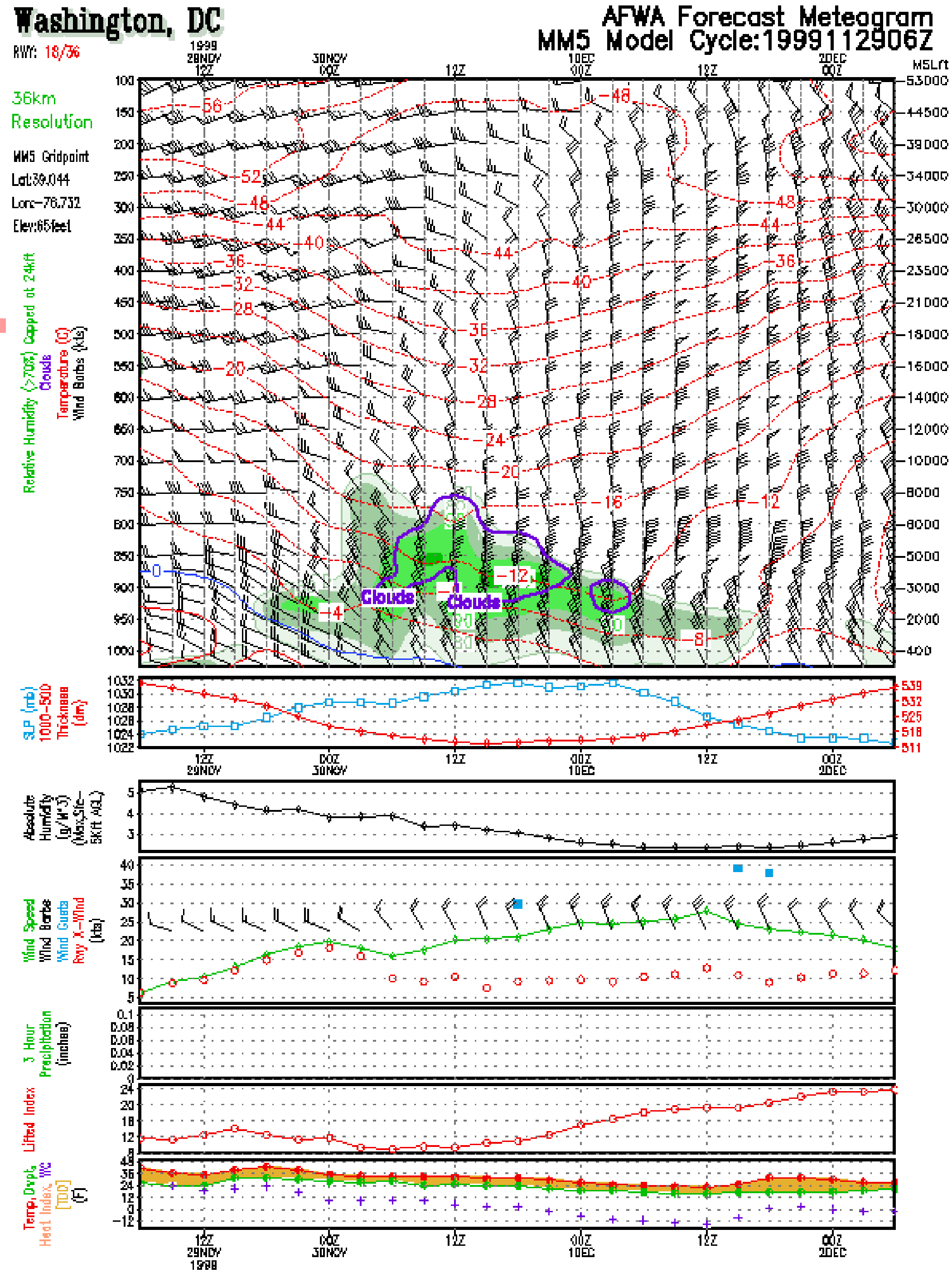
- Weather affects almost all human endeavor.
- What is important is not the weather itself, but the effect the weather has on the activity, operation or mission.
- Weather information that is timely, accurate and relevant to the activity can allow decision makers to anticipate and exploit opportunities for success and mitigate the impacts of mission-limiting weather.
- Very fine-scale, highly accurate forecast models, coupled with trained people, provide the keys to improved “mission effectiveness.”

BACK-UP SLIDES

Air Force Weather

MM5 Meteogram

Washington DC



It All Starts W
~3,600 PEOP

- **Officer Meteorologists (20%)**
- **Enlisted Technicians (68%)**
- **Government Civilian Experts (7%)**
- **Contract Assistance (5%)**
- **600 Guard + 100 Reservists**

… and a mission to support Air Force, Army, and other designated DoD agencies land, air, sea, and space operations

AFWA Weather Models

- **Mesoscale Model 5 (MM5) -** theater weather model
  - Forecasts used to support Air Force and Army combat operations
- **Real-Time Nephanalysis (RTNEPH) -** cloud analysis
  - Analysis initializes cloud forecast models and used by Navy weather models
- **Surface Temperature (SFCTMP) -** temperature analysis and forecast
  - Input to RTNEPH cloud analysis (Air Force use)
- **Snow Depth Analysis (SNODEP) -** snow depth and age analysis
  - Input to RTNEPH cloud analysis, Navy, and National Weather Service models
- **Advect Cloud (ADVCLD)/High Resolution Cloud Prognosis (HRCP)-** cloud forecasts
  - Cloud amount forecasts used to support National Programs and combat operations
- **Atmospheric Slant Path Analysis Model (ASPAM) -** vertical profiles
  - Atmospheric profiles used to support National Programs and NBC dispersion
- **Agricultural Meteorology (AGRMET) -** analysis of surface parameters (soil moisture, etc.)
  - Surface parameters used to support National Programs and USDA

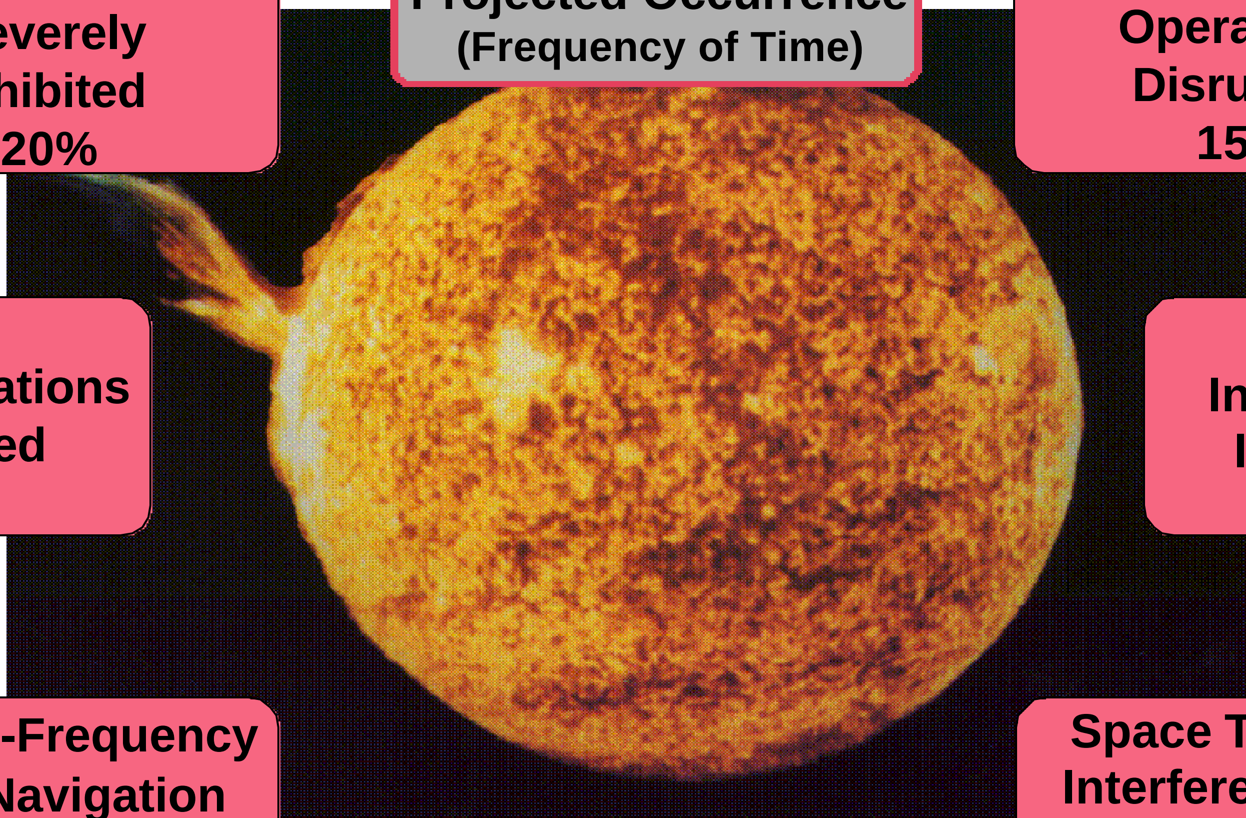
AFWA Weather Models

- **Mesoscale Model 5 (MM5) -** non-hydrostatic regional forecast model
  - 36/12/4 km horizontal resolution, 33 vertical levels
  - 36 km forecasts to 48 hours, inner nest forecasts to 24/12 hours
- **Real-Time Nephanalysis (RTNEPH) -** global analysis model
  - 25 nm horizontal resolution
  - Cloud amounts, bases and tops for 4 vertical layers, plus total cloud
- **Surface Temperature (SFCTMP) -** global analysis and forecast model
  - Analysis, 3-hour, and 4.5-hour forecast
  - 25 nm horizontal resolution
- **Snow Depth Analysis (SNODEP) -** global analysis model
  - 25 nm horizontal resolution
- **Advect Cloud (ADVCLD) -** global forecast model
  - Cloud amount at 5 levels plus total cloud
  - 25 nm horizontal resolution 0-12 hours, 50 nm horizontal resolution to 0-48 hours
- **Atmospheric Slant Path Analysis Model (ASPAM) -** point analysis model
  - Vertical profiles of temp, moisture, winds, aerosols, etc., available globally
- **Agricultural Meteorology (AGRMET) -** global analysis model
  - 25 nm horizontal resolution for 2 sub-surface layers (0-5 cm and 5-100 cm)

SPACE WEATHER

Key to 21st Century Warfare

RISK PROJECTION 2000



Projected Occurrence
(Frequency of Time)

***Geolocation Severely Inhibited**
20%

Satellite Operations Disrupted
15%

***HF Communications Disrupted**
23%

***SATCOM Intermittently Interrupted**
13%

***Single-Frequency GPS Navigation Significant Errors**
20%

Space Tracking Interference and Sat. Drag Events
11%

*** Projection is for SW Asia or Far East**

MILITARY METEOROLOGY

History: Origins

- Born in 1814 at the direction of the Army Surgeon General
  - Grown from physicians taking weather observations to the world's premiere military weather organization.
- Expanding telegraph networks and a growing military interest in meteorology brought weather services to the Army's Signal Service in 1870.
- The creation of the Signal Corps' Aeronautical Division in 1907 created new requirements for aviation support.
- With the dawning of World War I, the world quickly realized that weather impacts to modern warfare were significant, and that weather services were critical.

MILITARY METEOROLOGY
History: World War I

The rapid transmission by wireless of meteorological information is of the utmost importance…

General Erich F.W. Ludendorff

German General Staff, 1917

- British were intrigued at accuracy of German weather reports.
  - Germany's success was a direct result of weather observations being relayed by radio from submarines operating in the Atlantic Ocean.
- American military weather services were championed by Major General John J. Pershing and Brigadier General Billy Mitchell.
  - In 1917, Pershing requested meteorologists to support his American Expeditionary Forces in France.
  - Mitchell leveraged America's Signal Corps personnel and communications to produce accurate weather reports that became the basis of all orders for air operations.

MILITARY METEOROLOGY
History: World War II

Almighty and merciful Father…grant us fair weather for battle…
General George Patton, 1944

- General Arnold challenged the weather services for accurate and relevant long range forecasts to support global military operations.
- This set the stage for the most famous of all forecasts - in support of Operation Overlord -- the invasion of France in 1944.
  - General Eisenhower created a coalition weather team that had the greatest impact of any organization on the execution of the European invasion.
  - The team was keenly aware of the often contradictory joint mission conditions required.
  - The Allied weather team successfully predicted marginal conditions for the assault.
  - Achieved almost complete surprise because the Germans, denied weather information, expected the weather to delay any invasion.

MILITARY METEOROLOGY

History: Vietnam

This weather (satellite) picture is probably the greatest innovation of the war…

Lt General William Momyer, 1967

Never in the history of warfare have weather decisions played such an important role in operational planning as they have in Southeast Asia… **General Creighton Abrams, 1968**

- Unlike WW II, Weather organizations became physically and operationally separated from the operations centers
  - Target planning and integration slow and cumbersome
- New technologies presented greater environmental support challenges
- The Defense Meteorological Satellite Program (DMSP) developed to satisfy the need for higher resolution satellite data and imagery
  - Failure to integrate DMSP info into decision processes limited effectiveness
- When weather integrated into decision processes, results were positive
  - Integration in the rescue of US POWs at Son Tay resulted in moving the operation to the only usable day for over a month either side of the operation

MILITARY METEOROLOGY

History: Gulf War

- A critical lesson was learned during DESERT STORM: there are few benign environments in modern warfare.
- Even in a climatologically favorable environment, there are significant impacts.
  - Extremes in temperatures impacted sortie generation.
  - Clouds impacted tactical delivery techniques.
  - Abnormal precipitation impacted ground operations.
- DESERT STORM called the first “space war” because of the expanded use of weather, navigation, early warning, and surveillance satellites.
- DESERT STORM occurred during the third largest solar maximum on record.
  - First “space war” was conducted in a significantly hostile natural environment.
- During the 41 day war, 81 major solar flares occurred.
  - Flares degraded performance of communication systems for minutes to hours.
  - In addition solar flares and other space environment phenomena affected SATCOM and UHF communication during the evening hours.

MILITARY METEOROLOGY

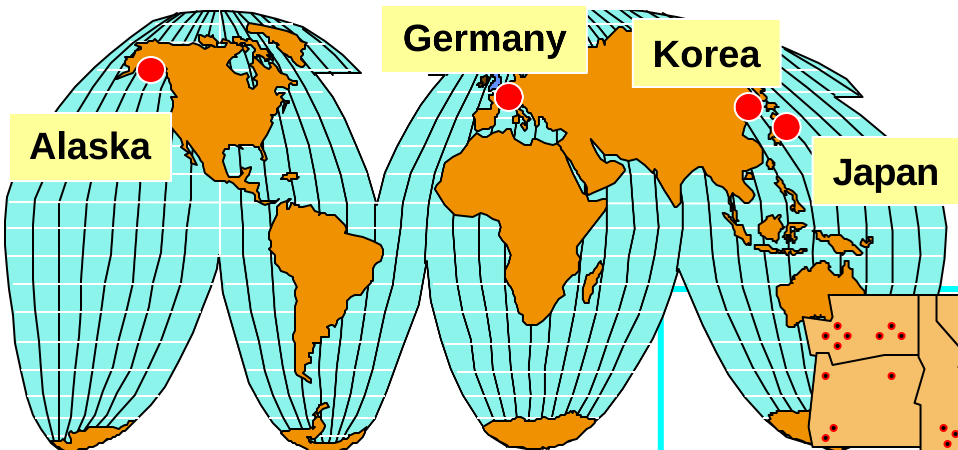
Military Operations Other than War

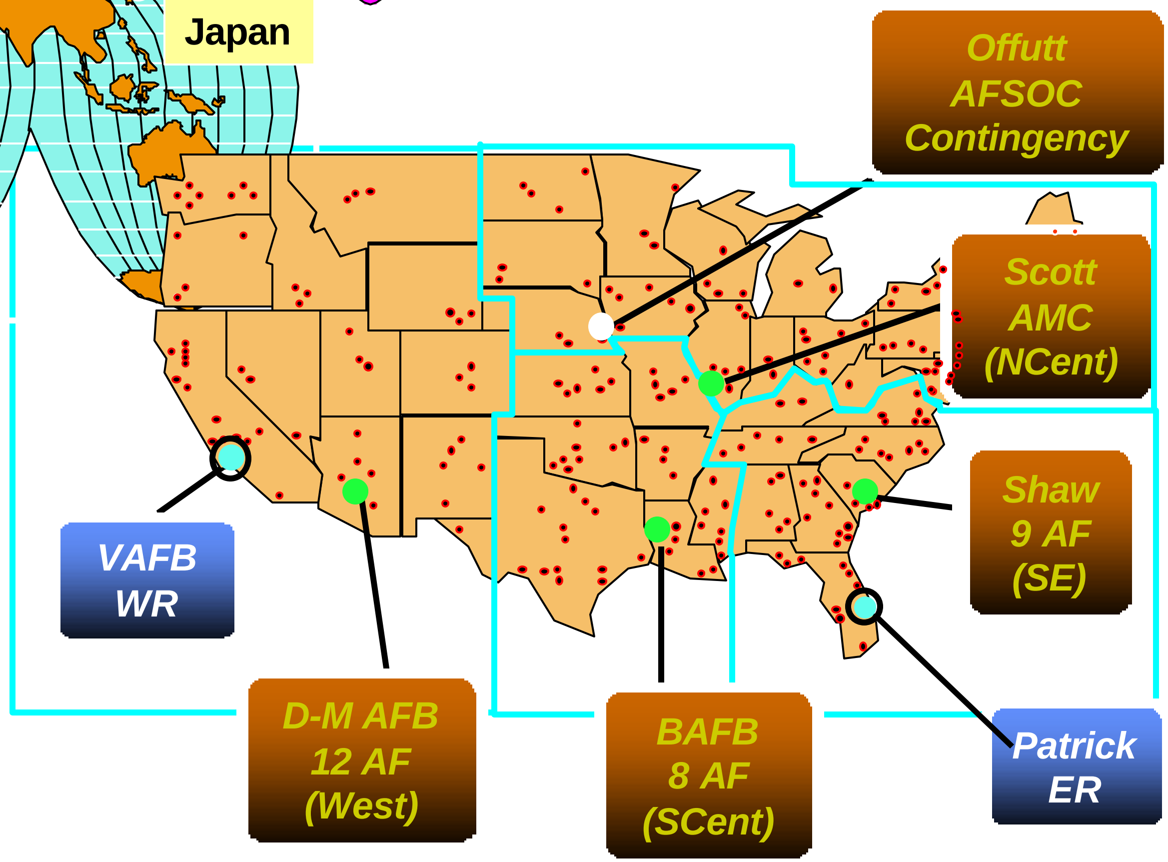
Air & space weather support is vital across the spectrum of warfighting. Contrast our Son Tay example with the failures at Desert One, the failed Iranian hostage rescue, where Air Force Weather personnel were not allowed to brief the crews local climatology or the execution weather. In Desert One, the opportunity for weather personnel and aircrews to determine mission thresholds and tailor the forecast to mission needs was lost. More challenging conditions, like those encountered in Bosnia, will affect deployment and employment operations. Effective planning will prepare alternative courses of action for the operations commander.

AFW ARCHITECTURE

Operational Weather Squadrons

WAR FIGHTER ALIGNED

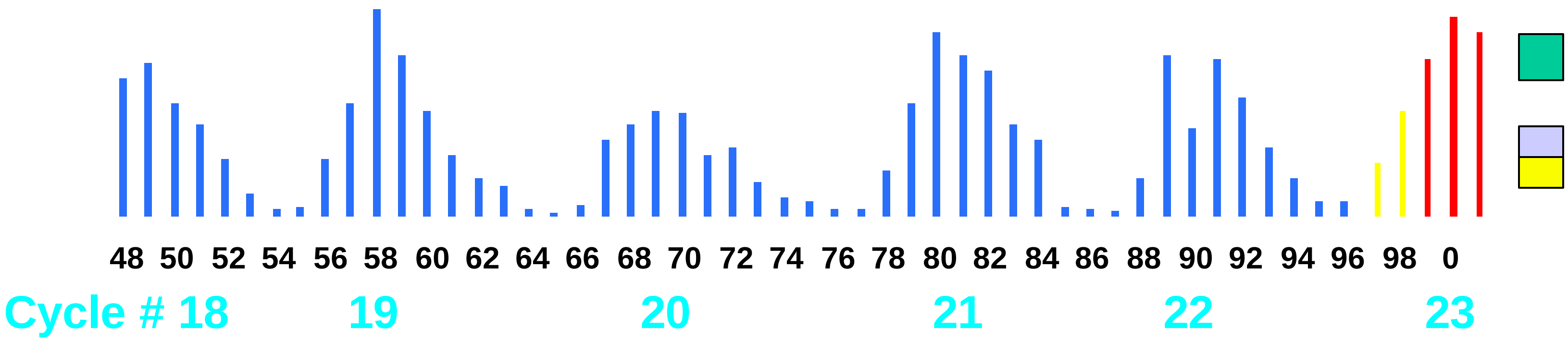




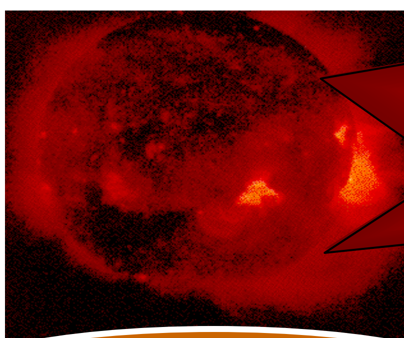
Approximately 132 Active Duty Weather Units Worldwide

TECHNOLOGIES:
SPACE WEATHER

Solar Cycle



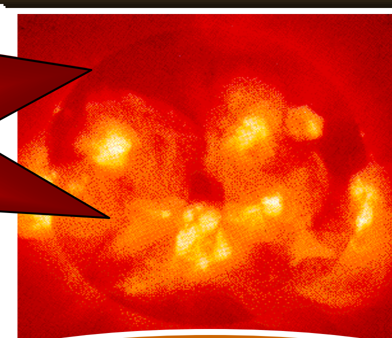
Solar Minimum (1996)



"Quiet" Sun

Expect Cycle 23 to be the Most Disruptive in 40 years

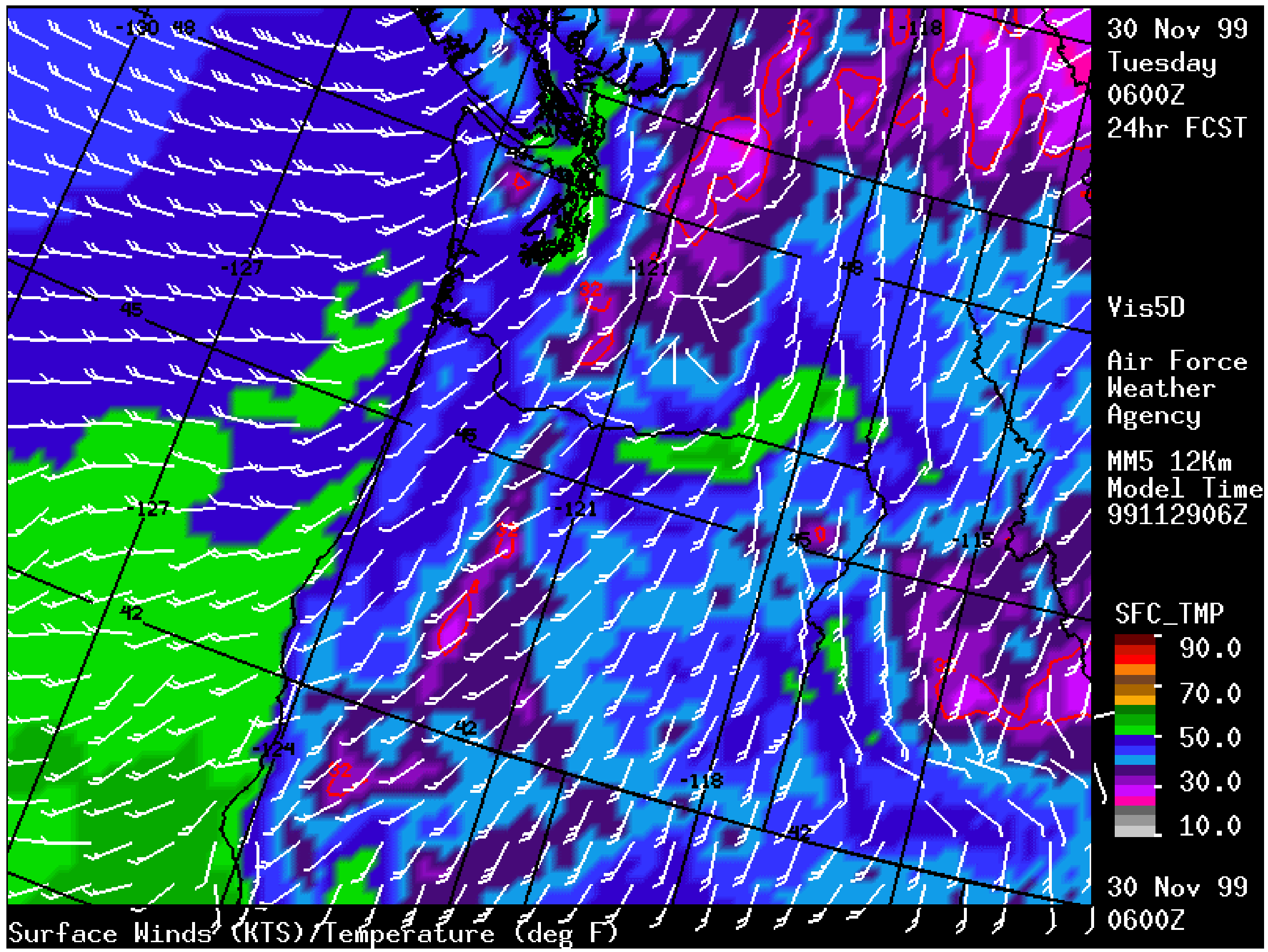
Solar Maximum (1999-2002)



"Disruptive" Sun

MM5 12km Cloud Tops/Surface Winds

24 Hr Forecast Valid 30 Nov 06Z



Naval Meteorology and Oceanography (METOC)

CAPT Barry Donovan

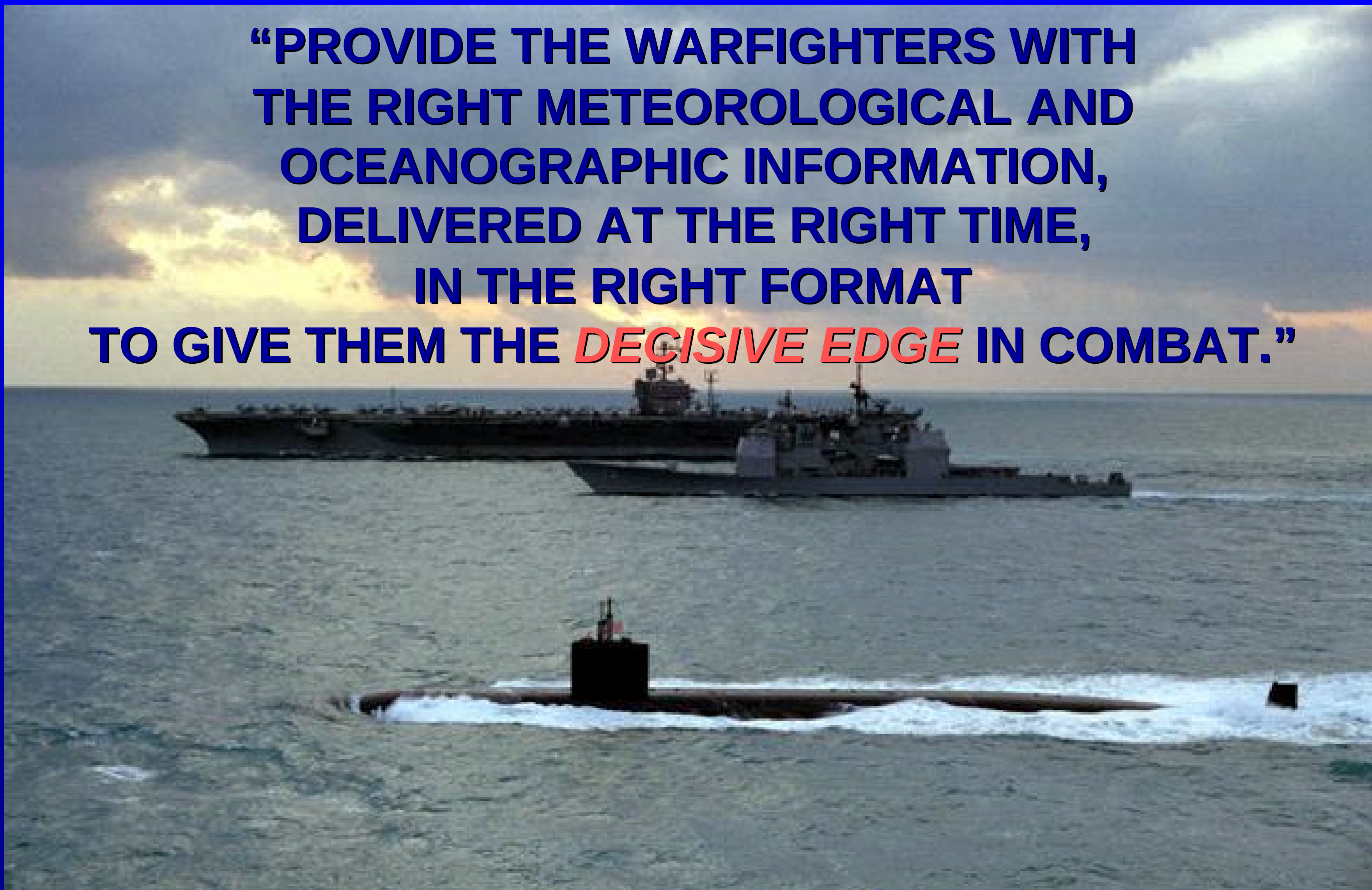
International/Interagency Division

Office of the Oceanographer of the Navy

Weather Information for Surface Transportation Symposium

30 November 1999

NAVY METOC MISSION



"PROVIDE THE WARFIGHTERS WITH THE RIGHT METEOROLOGICAL AND OCEANOGRAPHIC INFORMATION, DELIVERED AT THE RIGHT TIME, IN THE RIGHT FORMAT TO GIVE THEM THE *DECISIVE EDGE* IN COMBAT."

Three Primary Mission Areas

- Safety of the Fleet and the Navy Shore Establishment

- Application of Meteorology and Oceanography (METOC) to optimizing performance of Navy Platforms, Weapons, and Sensors

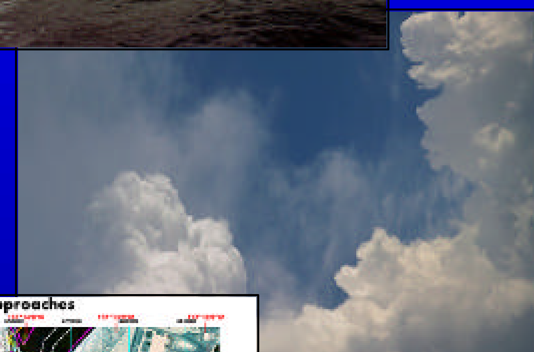
- Application of Geospatial Information and Services (GI&S) and Precise Time and Astrometry (PTA) Data to Navigation, Communications, and Targeting

Mission Application

•Oceanography

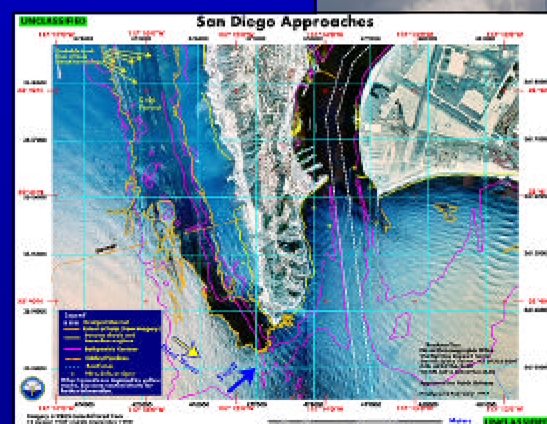
- Amphibious /Special Operations
- Acoustics for ASW, Mine Warfare

•Meteorology



- The Navy's Weather Service
- DoD Numerical Weather Products
- Regional METOC Centers

•Hydrography



- Digital seafloor data
- Supporting mapping, charting and geodesy

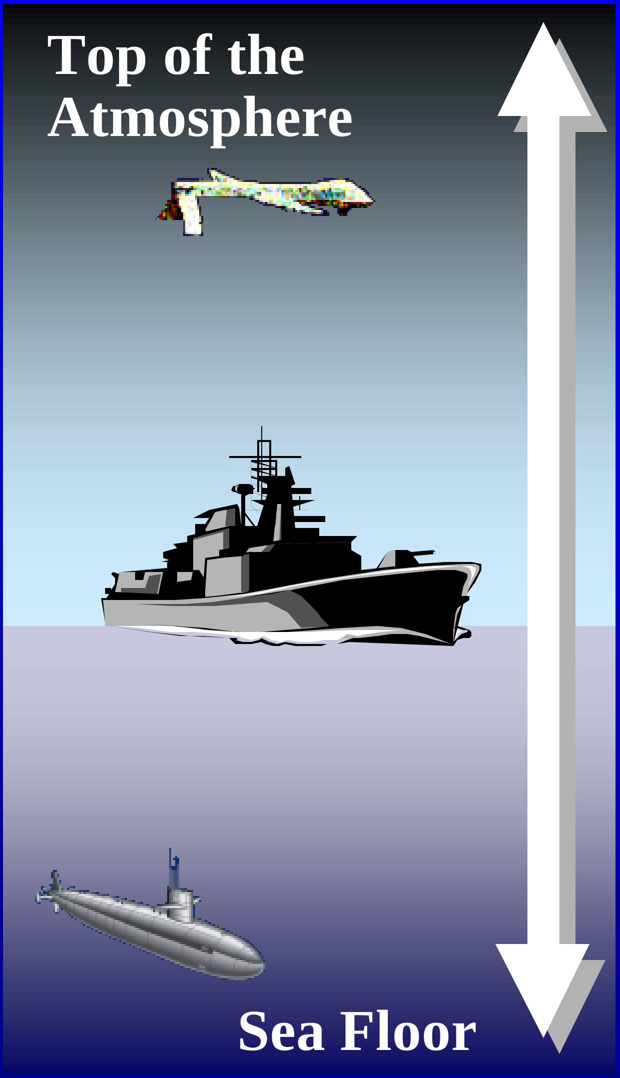
EXTENT OF NAVY METOC

FY 99 ASSETS:

7 REGIONAL & PRODUCTION CENTERS

8 MILITARY SURVEY SHIPS

3074 TOTAL END STRENGTH



Navy Meteorological Models

NOGAPS:

- Fleet Numerical Meteorology & Oceanography Center (FNMOC) spectral model, T159/L24
- Data assimilation; 0-10 day guidance
- Provides boundary conditions for COAMPS coarse mesh

COAMPS:

- FNMOC nonhydrostatic regional model, <9 km/L30
- Globally relocatable; Data assimilation
- Explicit moist physics; 0-72h guidance

COAMPS

- Developed by the Naval Research Laboratory
- High resolution mesoscale model
- Can integrate ocean and atmospheric conditions to allow surface fluxes of heat and moisture to exchange across the air-ocean interface ("coupled")
- Can be run with any number of nested grids.
- Grid size is determined by users needs - Grids can be relocated anywhere.

Naval Integrated Tactical Environmental Environmental Subsystem (NITES) 2000

- Navy METOC information storage and management suite.
- Each NITES is a set of meteorology and oceanography forecast, database, and decision aids tailored for specific platforms and uses,
- Five variants exist to support a variety of operators and platforms:
  - (1) large METOC forecast sites
  - (2) command and control systems
  - (3) aviation forecast sites
  - (4) mobile users
  - (5) foreign military users
- Open system design will provide complete interoperability with other DoD, Federal, and Allied command and control systems connected to the new Global Command and Control System (GCCS)

NITES 2000

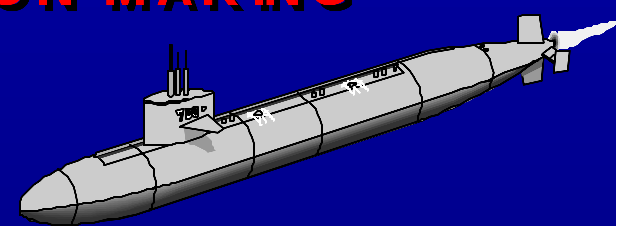
A Scalable library of, predominantly DII COE compliant, Meteorology and Oceanography applications, services and servers that include data, forecasting and sensor performance prediction capabilities:

Collect, Process, Store & Automatically Distribute **METOC Data**

Forecast tools for Wx & Ocean Conditions

Visualize **Sensor Performance Prediction** by making Graphical, User-Friendly Pictures

ENHANCE OPERATIONAL DECISION MAKING



TACTICAL ENVIRONMENTAL DATA SERVER (TEDS)

- Centerpiece of METOC data management for NITES
- Receives and stores observations, gridded forecast model output, and satellite imagery in a dynamic regional database
- TEDS is separate from models and applications
- Uses common extraction/merge routines for all applications
- Supports known Navy client applications & models. Can support other users' applications & models as well

TEDS

TEDS DATA includes historical data (what was) which is stored in flat files and dynamic data (what is) which is stored in a relational database. Dynamic data includes air and ocean measurements, observations, imagery and satellite data.

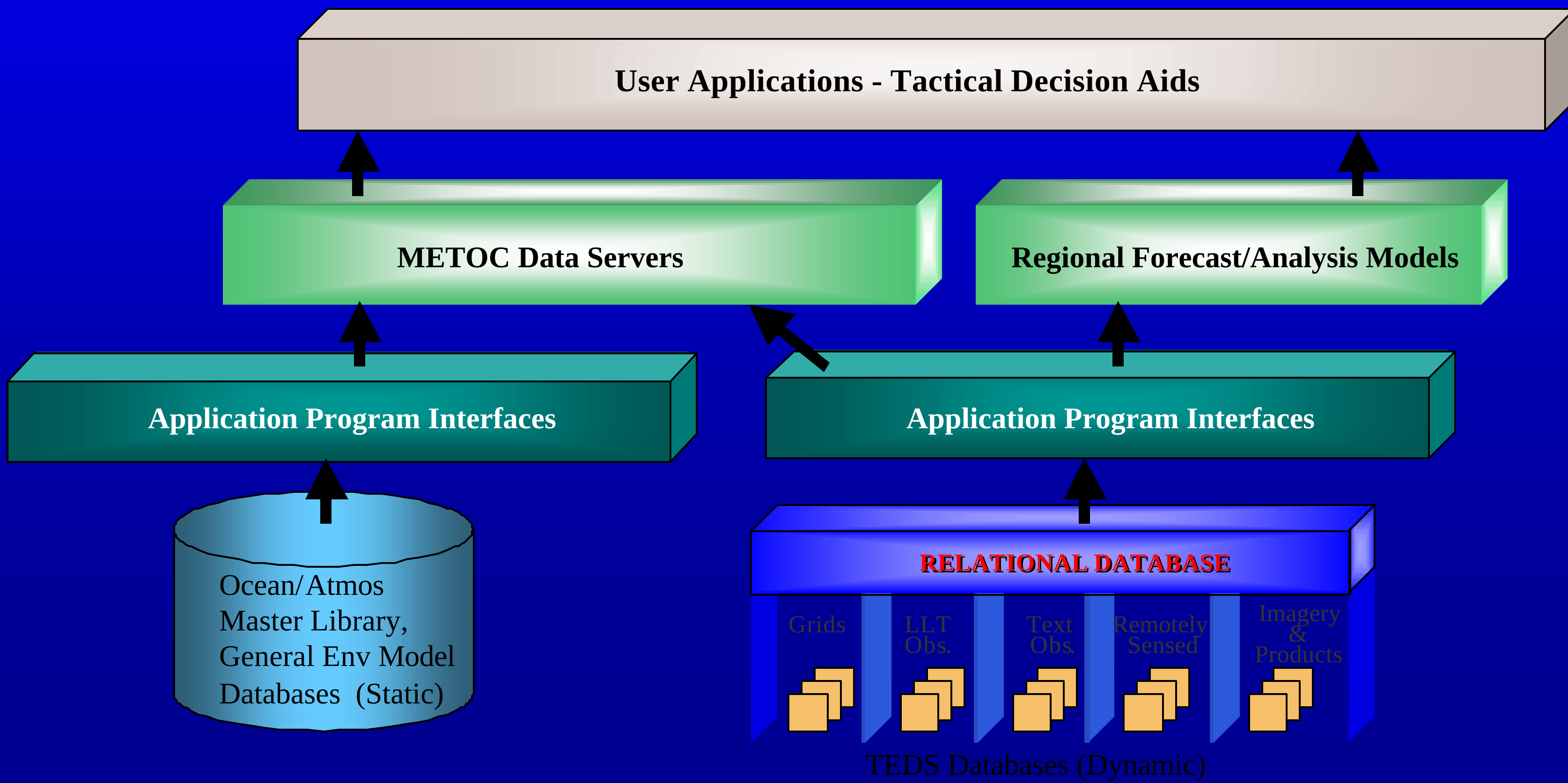
GEOPHYSICS numerical models are required to find current environmental values at places other than at those which are directly measured. TEDS uses global, regional and local models. Global and regional models are run on supercomputers and model output is imported into the TEDS relational database. Local, high resolution, models can be run locally and stored in the relational database.

TEDS is the key data segment of the Naval Integrated Tactical Environmental System (NITES) 2000. NITES 2000 is a scalable collection of applications and services which provide environmental data, forecasting, sensor performance prediction, and meteorology and oceanography capabilities.

TEDS ARCHITECTURE

Provides Common Access to the Climatological, In-Situ and Synoptic Databases

Uses Common Extraction/Merge Routines for all Applications



TEDS Performance Specs

Platforms – HP, Sun and NT

Operating Systems

- HPUX 10.20,
- Solaris 2.7
- NT 4.0

Sizes of Current TEDS DII COE Segments

– MDDBV	88.5 MB	MADBV	2 MB
– MDLLT	≥ 80 MB	MALLT	8 MB
– MDGRID	≥ 80 MB	MAGRID	14 MB
– MDIMG	≥ 40 MB	MAIMG	11 MB
– MDTXT	≥ 10 MB	MATXT	2 MB

METCAST

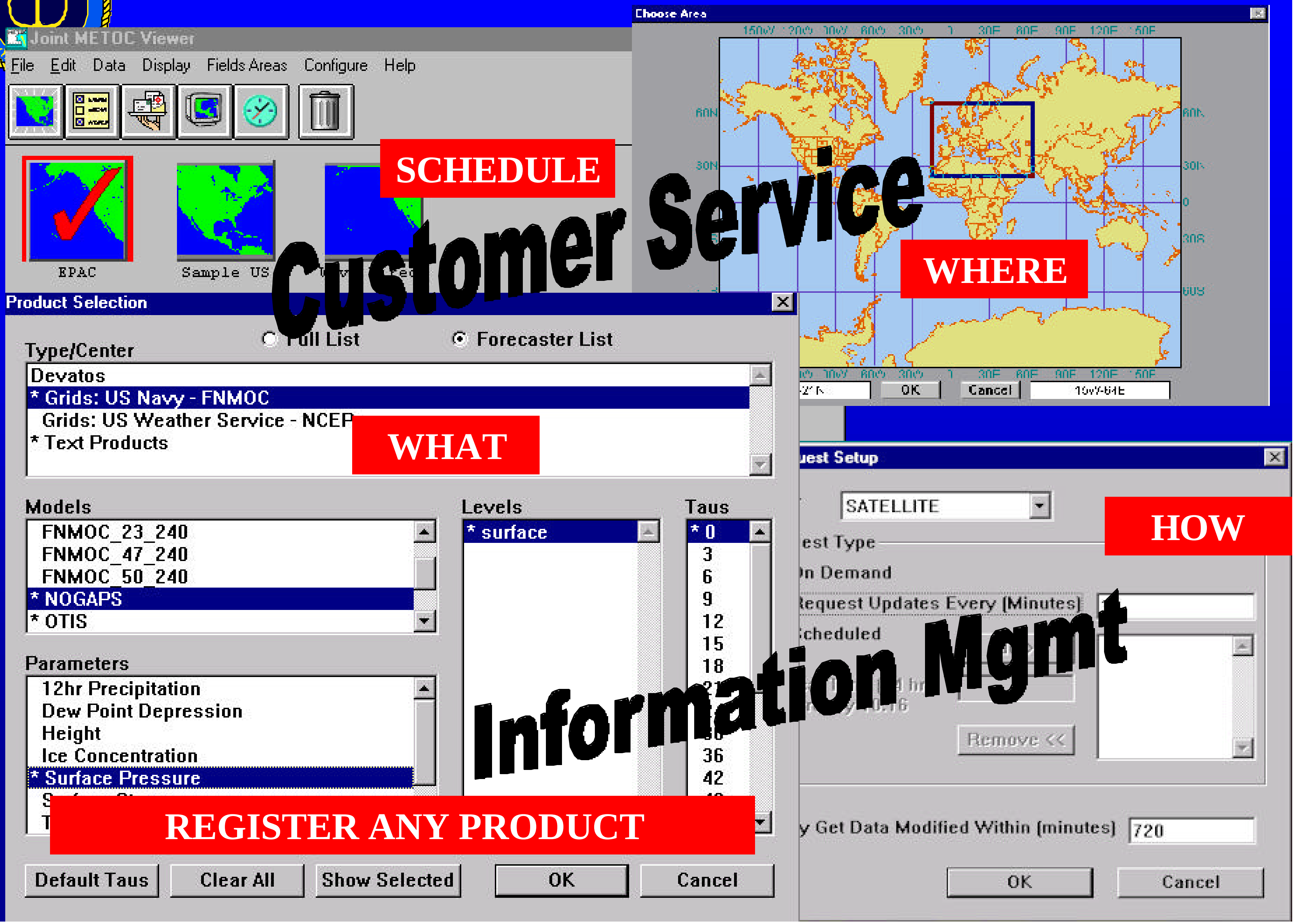
- A communication system to distribute information and let subscribers receive up-to-date data and updates.

- Information can include satellite images, product grids, observation reports, software updates, presentations, data sheets, etc.

- METCAST channels can contain one or several channels, each channel with one or more documents.

- METCAST channel system is comprised of:
  - clients (send requests to server)
  - server (takes request, parses it, sends products)
  - database of products to be delivered

METCAST



Joint METOC Viewer
File Edit Data Display Fields Areas Configure Help
EPAC
Sample US
SCHEDULE
Customer Service
Choose Area
WHERE
OK
Cancel
Product Selection
Full List
Forecaster List
Type/Center
Devatos
* Grids: US Navy - FNMOC
Grids: US Weather Service - NCEP
* Text Products
WHAT
Models
FNMOC_23_240
FNMOC_47_240
FNMOC_50_240
* NOGAPS
* OTIS
Levels
* surface
Taus
* 0
3
6
9
12
15
18
36
42
Parameters
12hr Precipitation
Dew Point Depression
Height
Ice Concentration
* Surface Pressure
Information Mgmt
REGISTER ANY PRODUCT
Default Taus
Clear All
Show Selected
OK
Cancel
SATELLITE
HOW
On Demand
Request Updates Every (Minutes)
Remove <<
Get Data Modified Within (minutes)
720
OK
Cancel

SO WHAT?

- Bottom line is that the U. S. Navy develops and disseminates state of the art atmospheric models and products, in support of our mission.
- Many of these can be used to support surface transportation as well.
- We at the Navy will continue to work with the National Weather Service and OFCM to make these available for surface transportation purposes, and look forward to seeing the developments that result from this symposium.

Symposium on Weather Information for Surface Transportation

Andrew Humphrey

Meteorologist, WTTG-TV FOX5

Tuesday, Nov. 30, 1999

Silver Spring, MD

Introduction

- Weather is dangerous when it greatly reduces or erases the function of one or more of our senses while operating a vehicle.
- Meteorologists and Safety Officials are dangerous they reduce or erase communication.

Weather Hampering/Eliminating Senses

- Visibility
  - Fog, Heavy Rain, or Snow Can Blind
  - Sunshine or Haze Can Blind
- “Feel” for the road/surface
  - Snow, Freezing Rain, or Ice = Slippery
  - Rain or Mist = Slick
  - Wind Will Take Away
  - Heat Will Warp

Successful Communication

- Understanding and Unity Amongst All
- Synchronicity Among Like-Professionals
- Clear, Correct, Concise, and Quick Among Different Professions
- Constant Contact

Understanding and Unity Amongst All

- Have General Knowledge of Others Jobs
  - Structure
  - Inner Workings (e.g., timeframes and budgets)
- Have General Understanding of Others Roll(s)
  - How and When Members Participate
- Unity <u>Does NOT Equal</u> Conformity

Synchronicity Among Meteorologists

- Weather: What Is Happening
- Forecast: What May or May Not Happen
- Terminology
- Coverage

Clear, Correct, Concise, and Quick Among Professions

- Stated Plainly and Simply
  - What is happening
  - What will happen
  - Suggestions on reaction when necessary
- Accuracy and Preciseness
  - Be specific about weather and its impact
- Inform As Fast As Possible

Constant Contact Between Meteorologist and Others

- Maintain Connection
  - Direct by same means
  - Indirect by alternate means
- Dependent Upon Conditions Not Time
  - Time of hazard is indefinite

Current & Future Capabilities of the Commercial Weather Services Association (CWSA)

Commercial Weather Service Information Services

&

Capabilities for Surface Transportation Decision Support

WIST Symposium - Panel 2

Maria A. Pirone

Director, Global Data Products & Services

WSI Corporation

CWSA Members

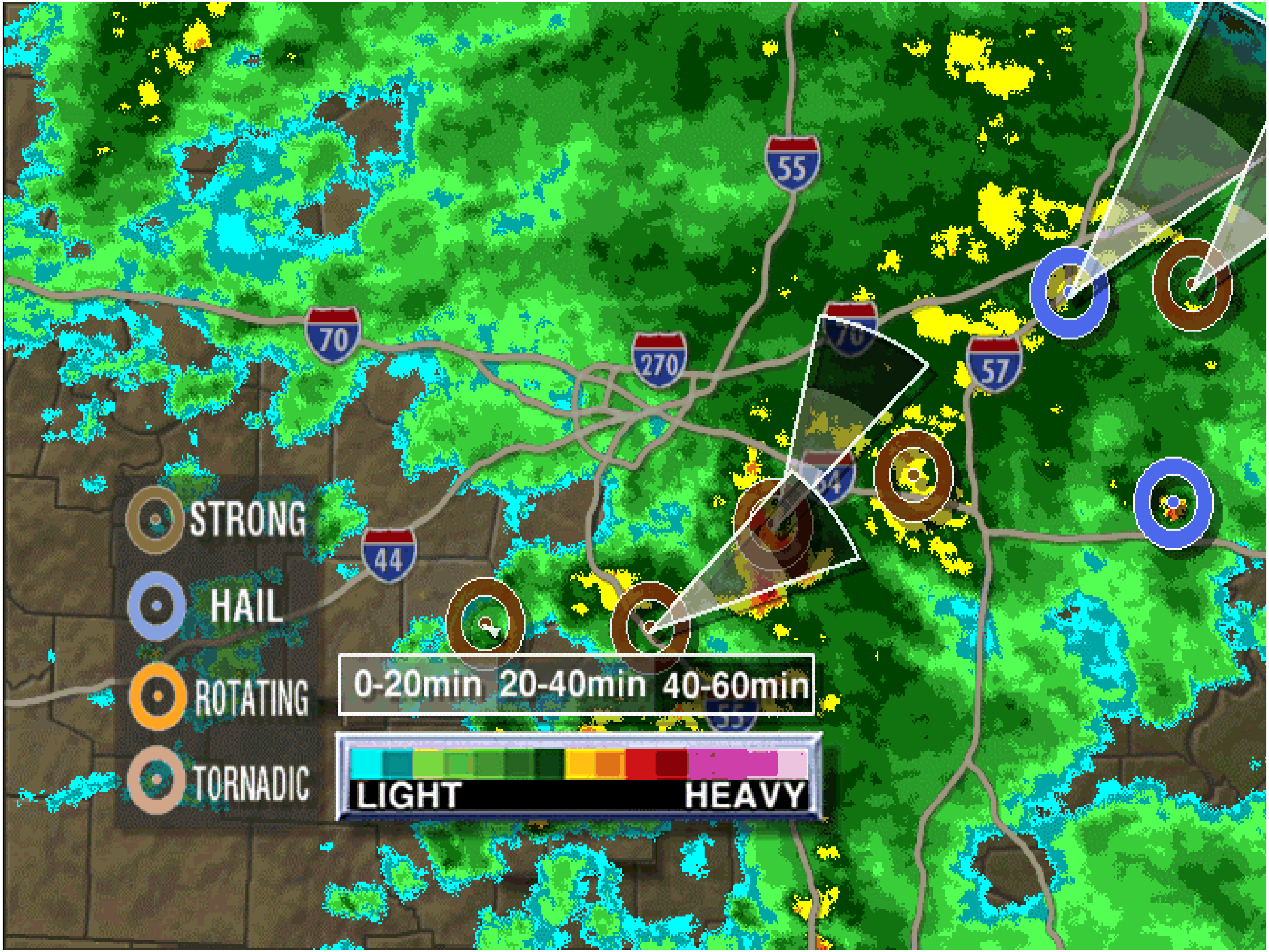
- 39 Commercial Weather Companies
- Those serving Surface Transportation include-
  - Accuweather
  - DTN Kavouras Inc.
  - Litton-WSI
  - Unisys
  - Weather Data Inc

Markets Served

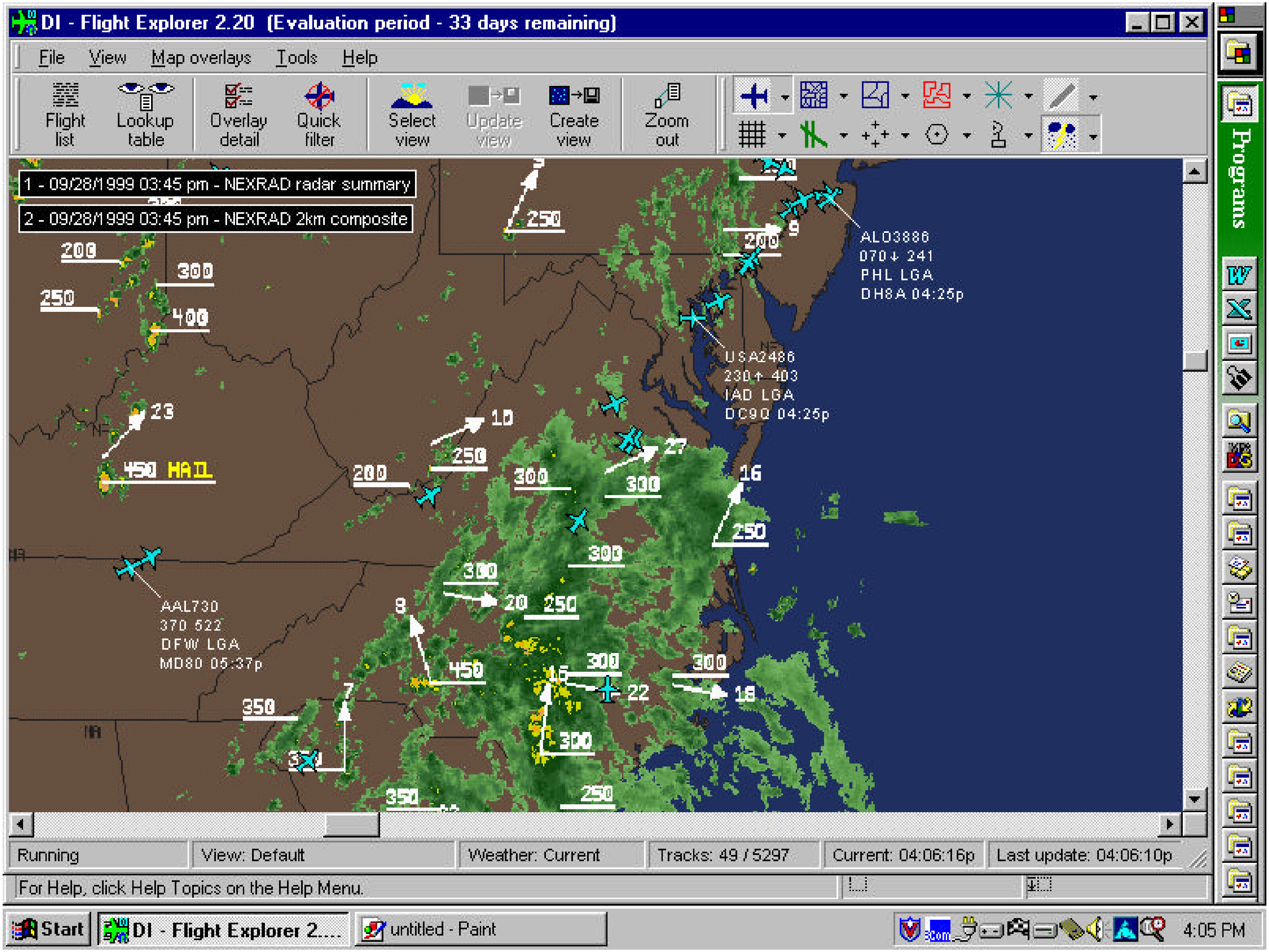
- Trucking Firms
- Railroads
- Pipelines
- State, County and Local Highway Departments
- State RWIS programs
- Highway Information Kiosks
- Maintenance and Operations
- Police and Emergency Management

Services

- Full suite of weather data including:
  - Customized current and forecast weather maps, charts, reports
  - Highway conditions reports
  - Satellite Cloud Coverage & Radar data
  - Weather watches and warnings
- Training
- Consulting



55
70
270
70
57
44
64
55
STRONG
HAIL
ROTATING
TORNADIC
0-20min 20-40min 40-60min
LIGHT
HEAVY

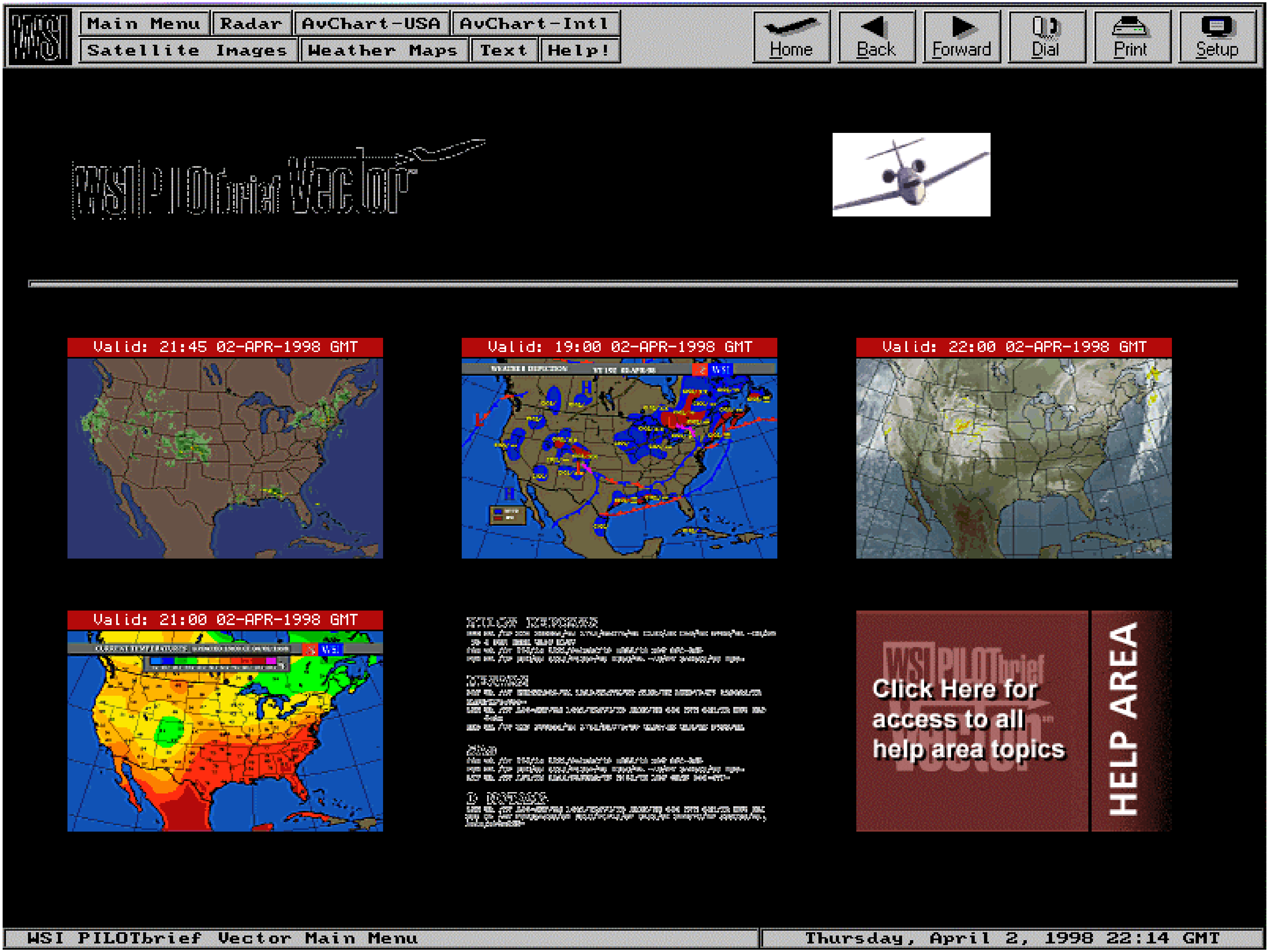

DI - Flight Explorer 2.20 (Evaluation period - 33 days remaining)
File View Map overlays Tools Help
Flight list
Lookup table
Overlay detail
Quick filter
Select view
Update view
Create view
Zoom out
1 - 09/28/1999 03:45 pm - NEXRAD radar summary
2 - 09/28/1999 03:45 pm - NEXRAD 2km composite
450 HAIL
ALO3886
070↓ 241
PHL LGA
DH8A 04:25p
USA2486
230↑ 403
IAD LGA
DC9Q 04:25p
AAL730
370 522
DFW LGA
MD80 05:37p
Running
View: Default
Weather: Current
Tracks: 49 / 5297
Current: 04:06:16p
Last update: 04:06:10p
For Help, click Help Topics on the Help Menu.
Start
DI - Flight Explorer 2....
untitled - Paint
4:05 PM
Programs

Services

- Collection, processing and dissemination of third party sensor information-
  - "Kavouras has the capability to access road weather data collection platforms, e.g. pavement sensors, analyze this data, and create value added products and transmit it back to the DoT's for operational decision support purposes."

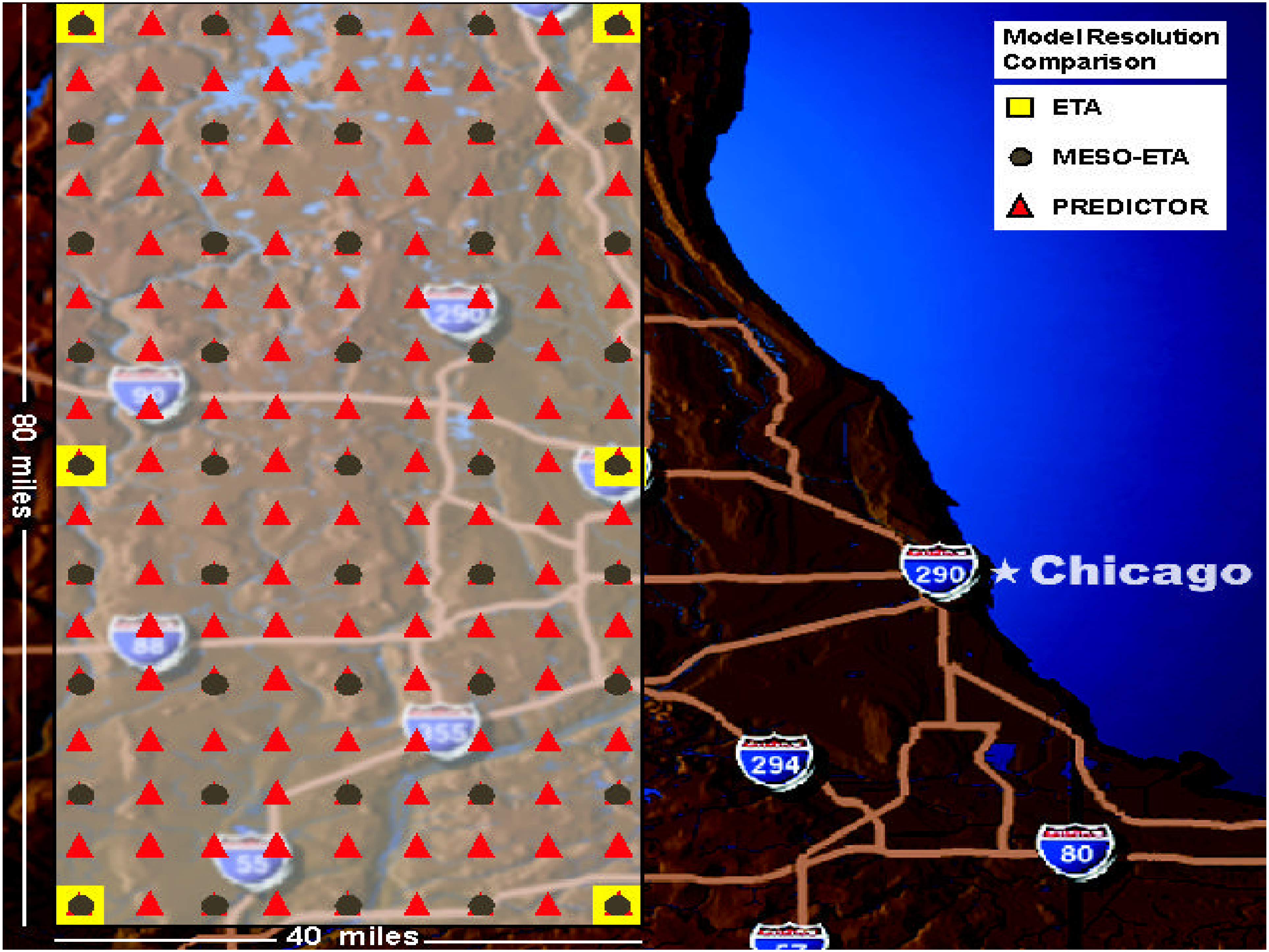
Delivery Systems

- Weather paging systems
- Weather workstations and display systems
- Communications systems, including
- Internet access
- Direct Satellite data feeds
- Dial-up access
- Software packages for weather display and analysis

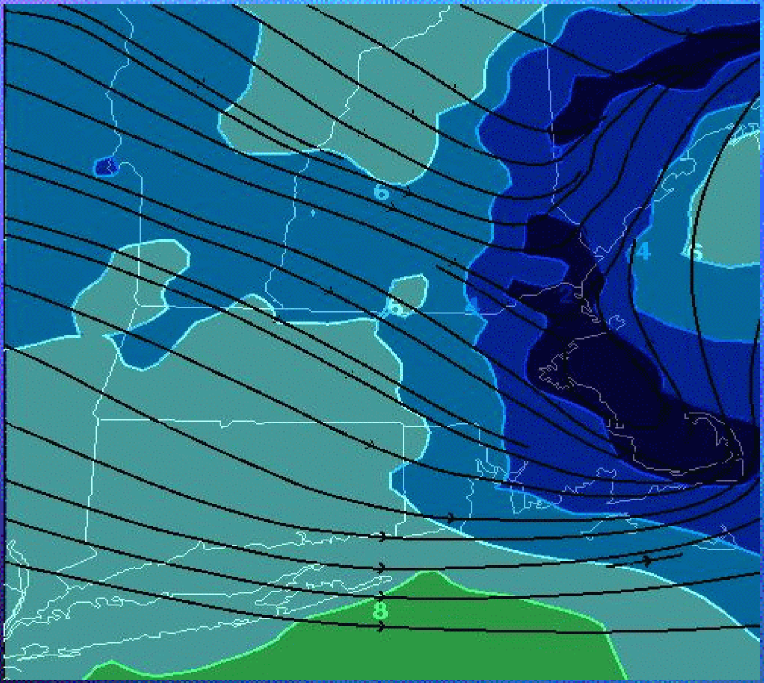

Main Menu
Radar
AvChart-USA
AvChart-Intl
Satellite Images
Weather Maps
Text
Help!
Home
Back
Forward
Dial
Print
Setup
WSI PILOTbrief Vector
Valid: 21:45 02-APR-1998 GMT
Valid: 19:00 02-APR-1998 GMT
Valid: 22:00 02-APR-1998 GMT
Valid: 21:00 02-APR-1998 GMT
Click Here for access to all help area topics
HELP AREA
WSI PILOTbrief Vector Main Menu
Thursday, April 2, 1998 22:14 GMT

New Services

- Local, Local Numerical Weather Prediction Forecasting Capabilities
- Better Visualizations
- Improved Data Fusion Techniques

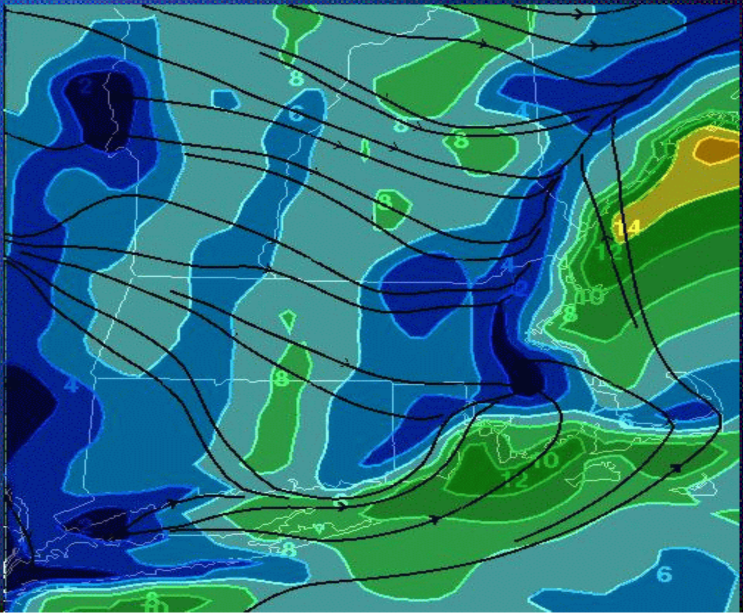

Model Resolution Comparison
ETA
MESO-ETA
PREDICTOR
80 miles
40 miles
Chicago
290
90
88
355
55
294
80

Local, Local Modeling

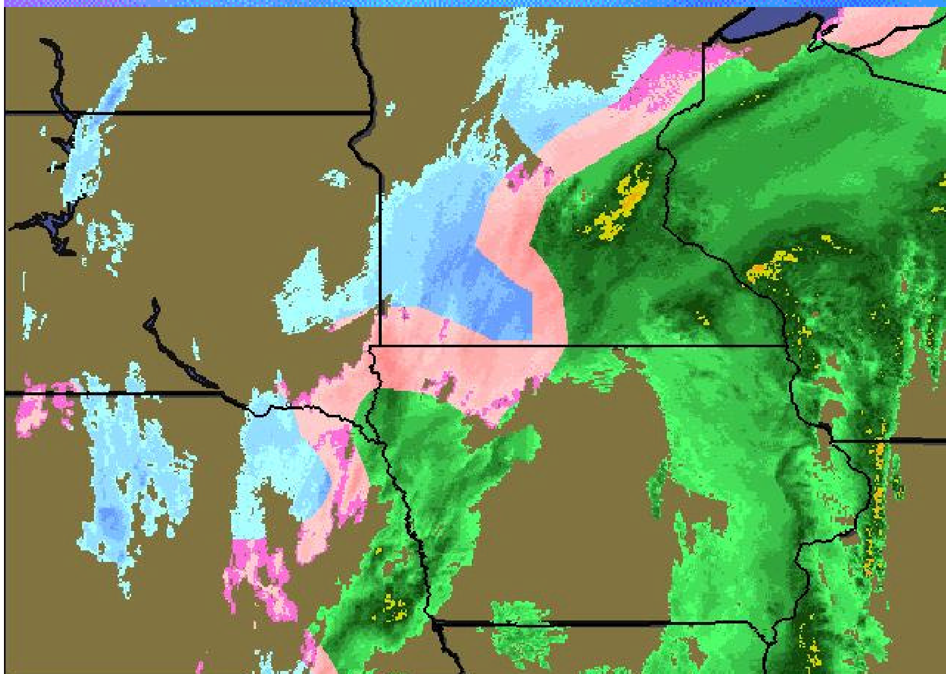


NCEP's 20 km
Meso-Eta Model

WSI's 10 km
Predictor (MM5) Model

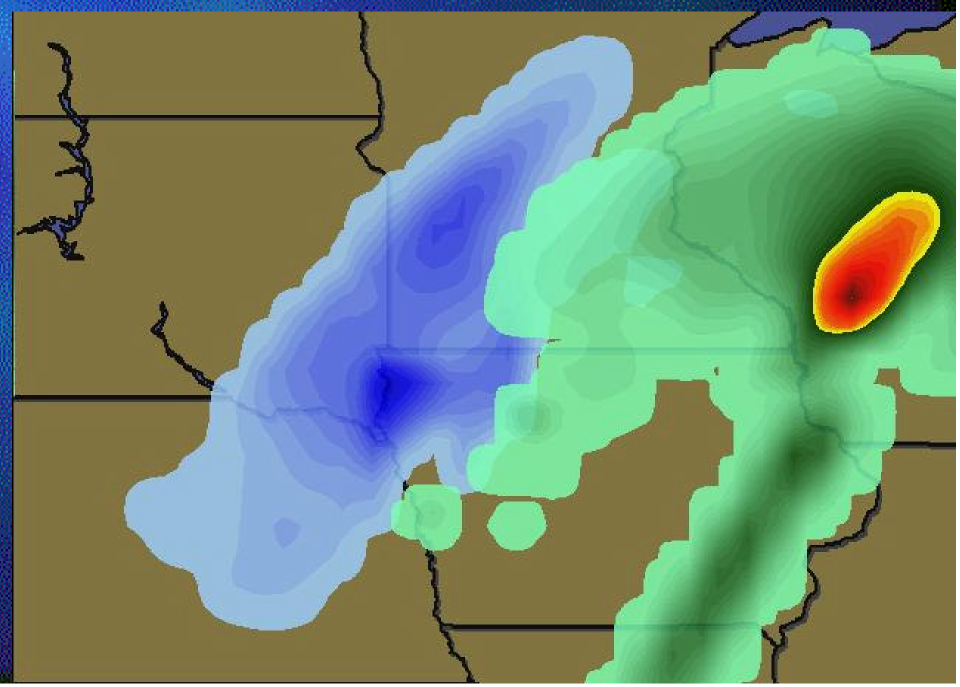


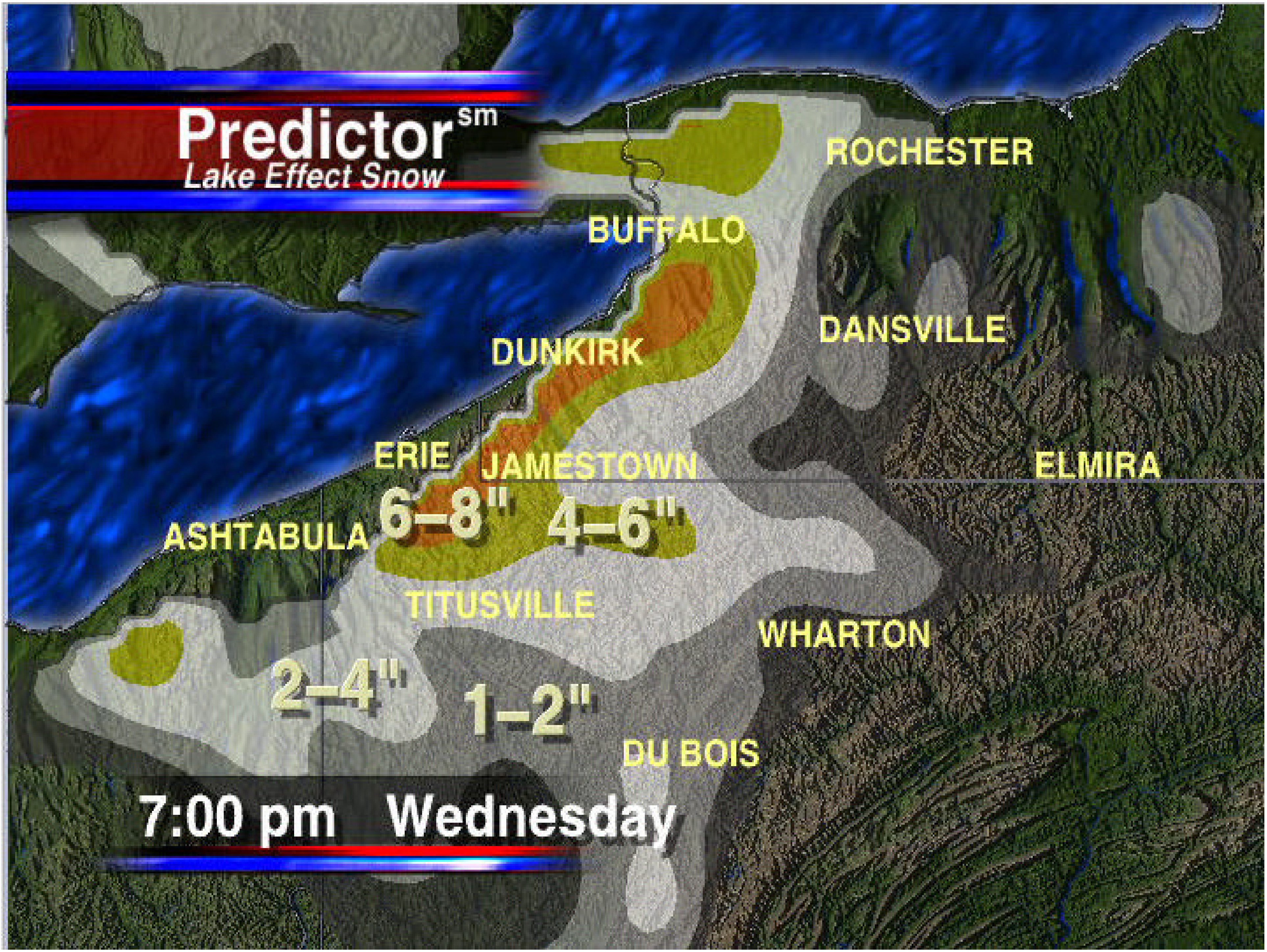
Actual vs 12 hr Forecast

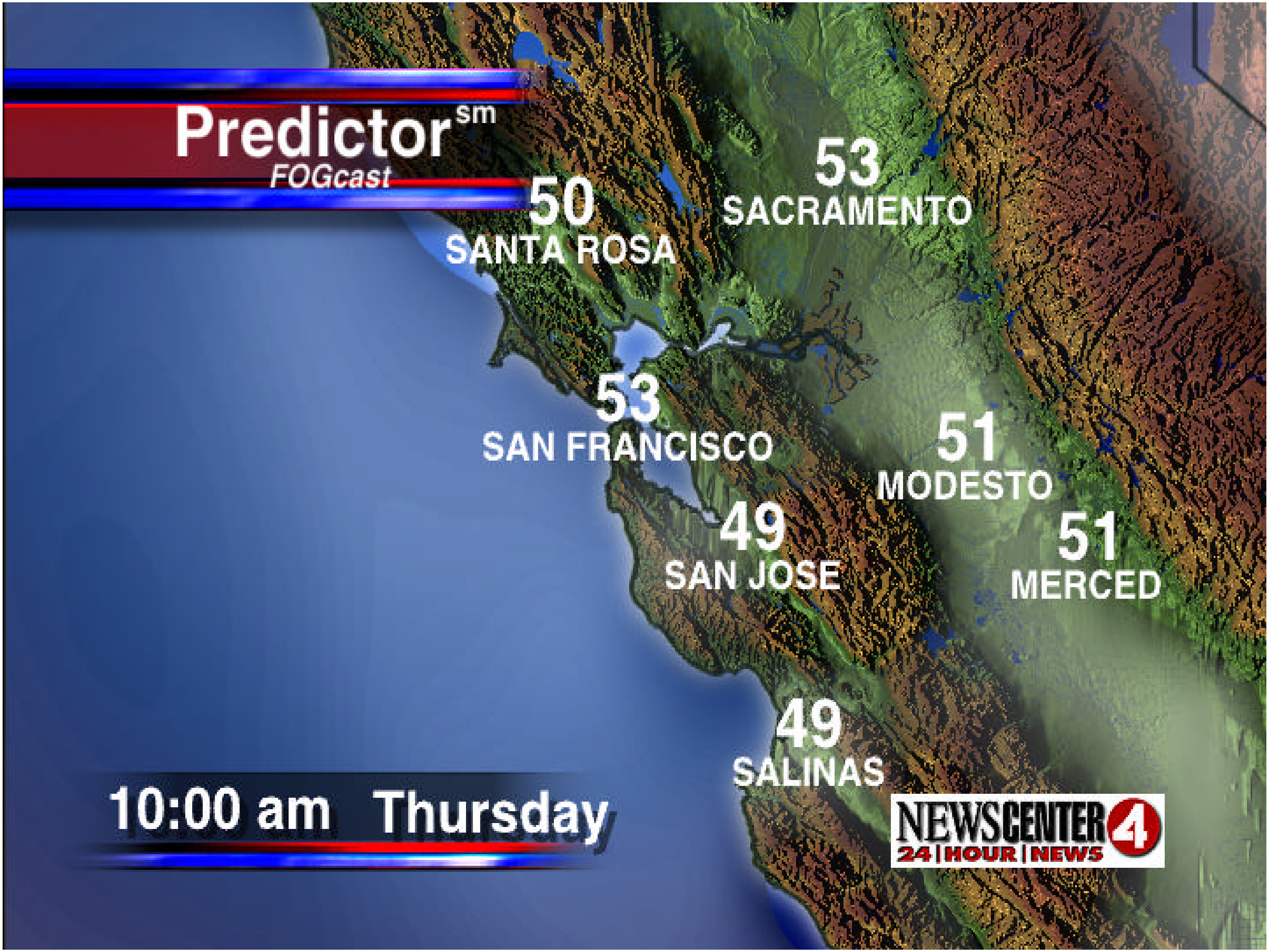


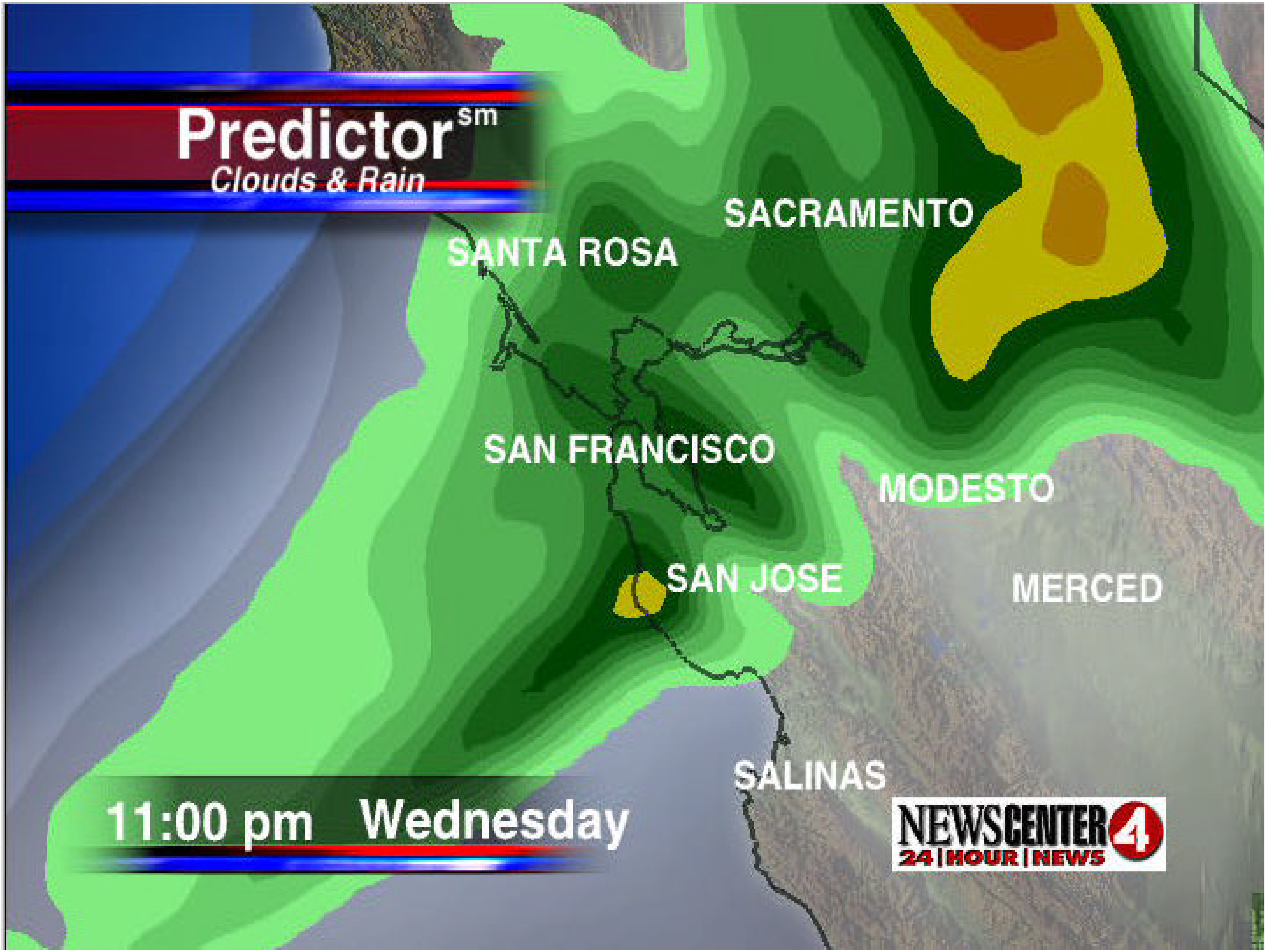
Actual NOWrad Winter Storm Mosaic

12 hr Predictor Forecast

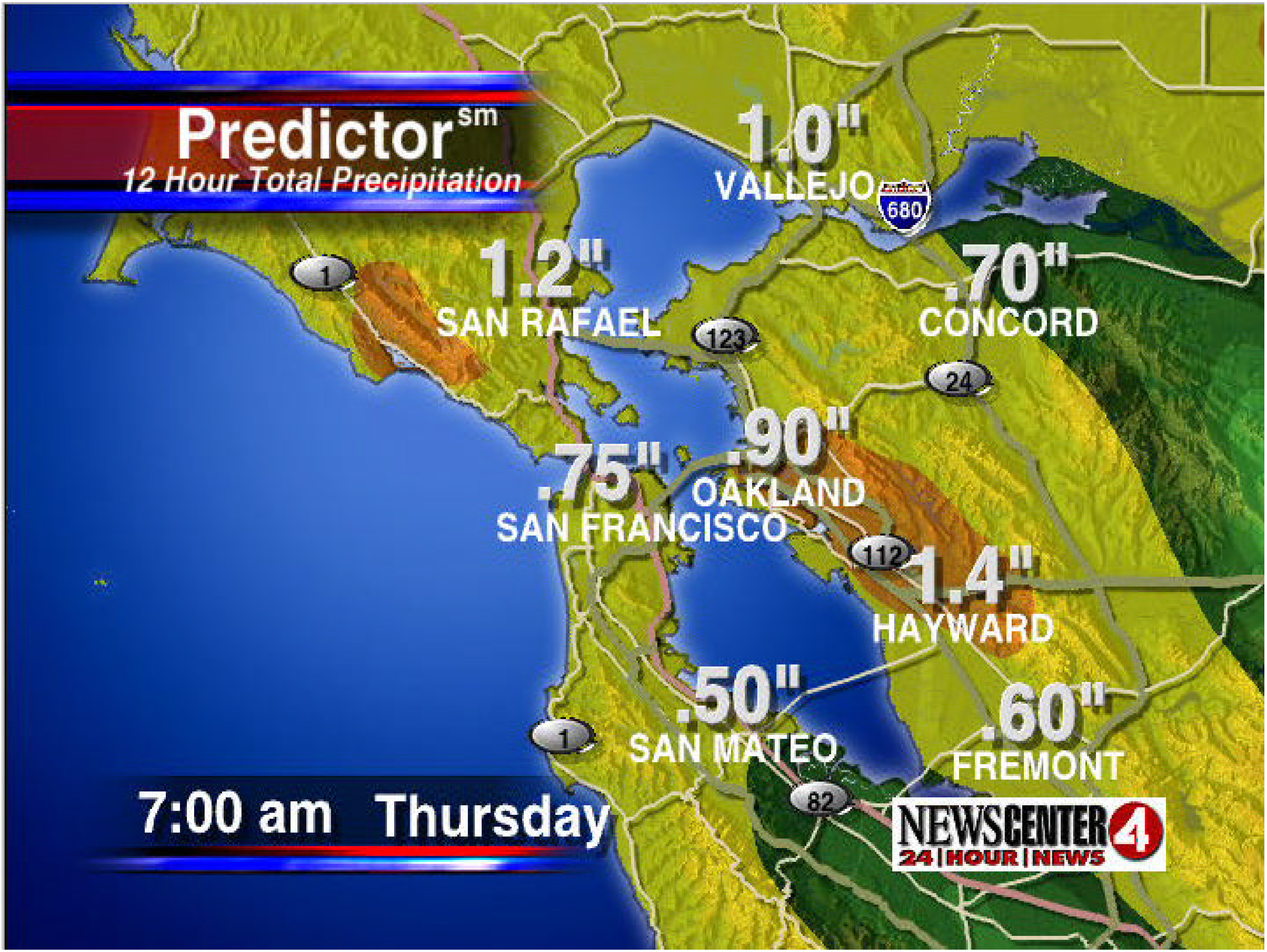



Predictor sm
Lake Effect Snow
ROCHESTER
BUFFALO
DANSVILLE
DUNKIRK
ERIE
JAMESTOWN
ELMIRA
6–8"
4–6"
ASHTABULA
TITUSVILLE
WHARTON
2–4"
1–2"
DU BOIS
7:00 pm Wednesday


Predictor sm
FOGcast
50
SANTA ROSA
53
SACRAMENTO
53
SAN FRANCISCO
51
MODESTO
49
SAN JOSE
51
MERCED
49
SALINAS
10:00 am Thursday
NEWSCENTER 4
24 HOUR NEWS



Predictor sm
Clouds & Rain
SACRAMENTO
SANTA ROSA
SAN FRANCISCO
MODESTO
SAN JOSE
MERCED
SALINAS
11:00 pm Wednesday
NEWSCENTER 4
24 | HOUR | NEWS


Predictor sm
12 Hour Total Precipitation
1.0"
VALLEJO
680
1.2"
SAN RAFAEL
1
123
.70"
CONCORD
24
.90"
OAKLAND
.75"
SAN FRANCISCO
112
1.4"
HAYWARD
.50"
SAN MATEO
1
.60"
FREMONT
82
7:00 am Thursday
NEWSCENTER 4
24 | HOUR | NEWS

Summary

- Surface Transportation will benefit from technology's impact on numerical weather prediction, analysis tools and dissemination methodologies.
- CWSA members are leaders in providing the most technically advanced solutions at the most affordable prices---and are prepared to meet these needs.

Symposium on Weather Information for Surface Transportation:

Commercial Weather Information Production Capabilities and Services

Dave Jones
Meteorologist NBC4 Washington, DC
Principal Investigator, WeatherNet4
dave.jones@nbc.com

Cambridge, Maryland

SOME BASIC BROADCAST RESEARCH FACTS...

THE WEATHER FORECAST

- **Number 1 Reason People Watch Local News**
- **If a TV Station Does NOT Own Severe Weather Coverage… They will <u>NEVER</u> Be #1**
- **LOCAL weather is the most important…<u>transportation issues</u>**

STORM CENTER 4

FORECAST PRIORITIES

- Construct an ACCURATE forecast
    - Describe the weather situation NOW
    - FOCUS on the FORECAST
        - As Detailed as Possible
- I try to make my forecasts truly Didactic

STORM CENTER 4

FORECAST PRIORITIES

Didactic

[DIE • DAK • TICK]

A[1]. *adj.* Designed to convey information in a pleasurable and entertaining manner.

B[2]. *n.* The art of teaching.

NBC4
WASHINGTON, D.C.

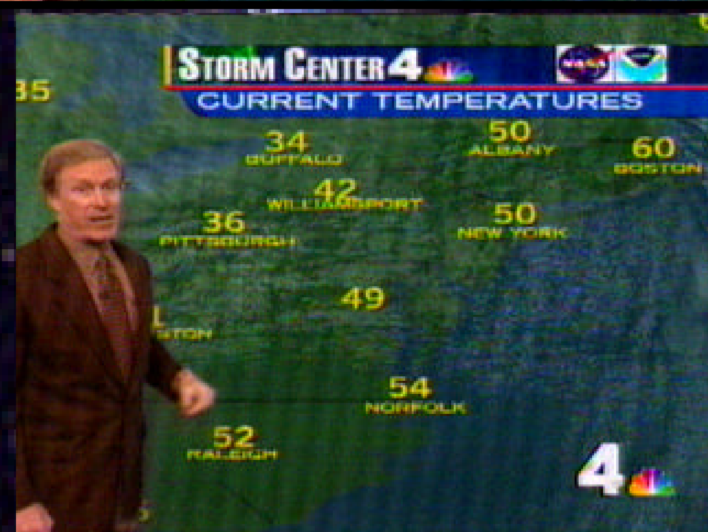
STORM CENTER 4

RADAR PRESENTATIONS

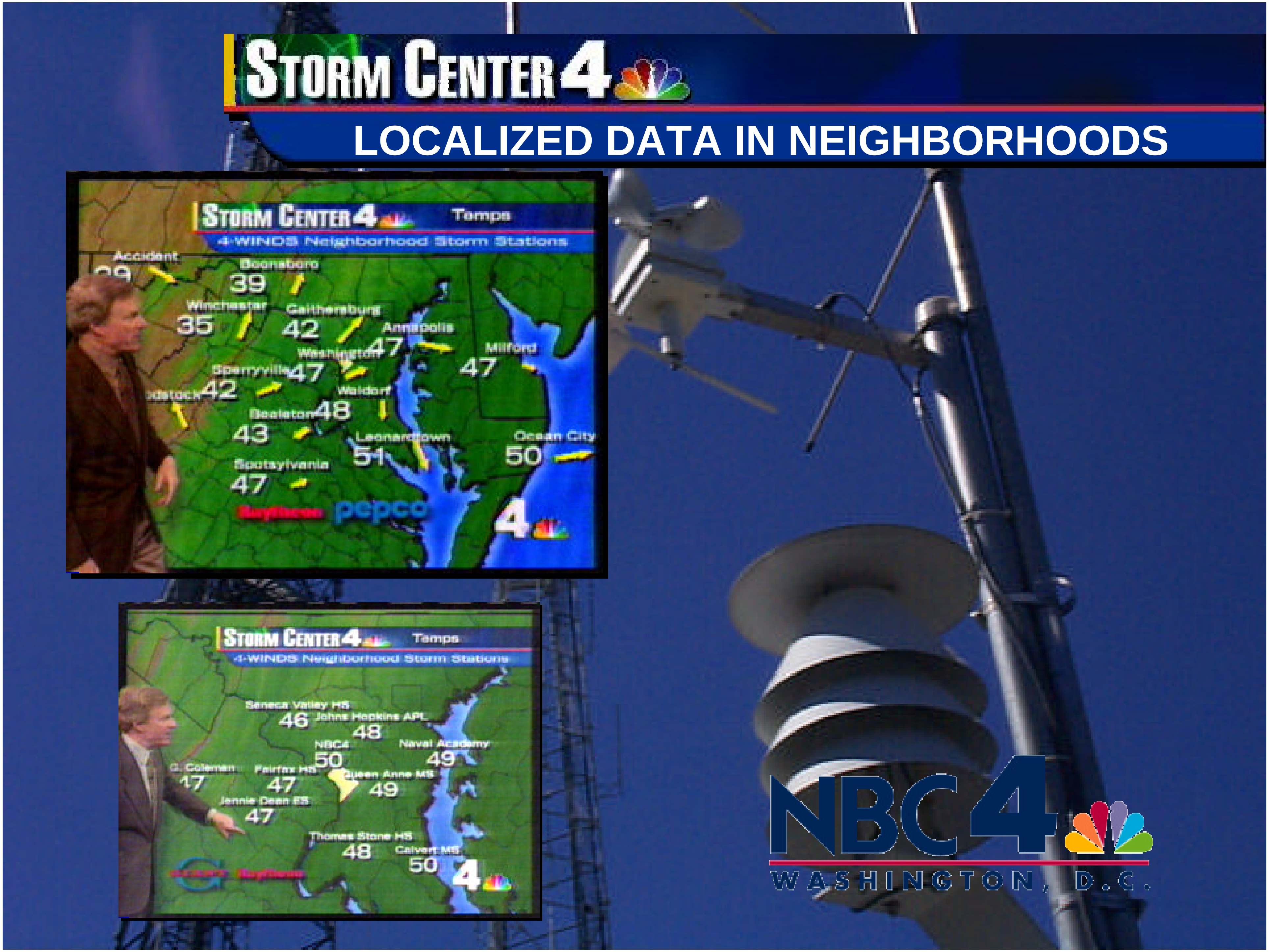
NBC4
WASHINGTON, D.C.

STORM CENTER 4

SATELLITE IMAGERY

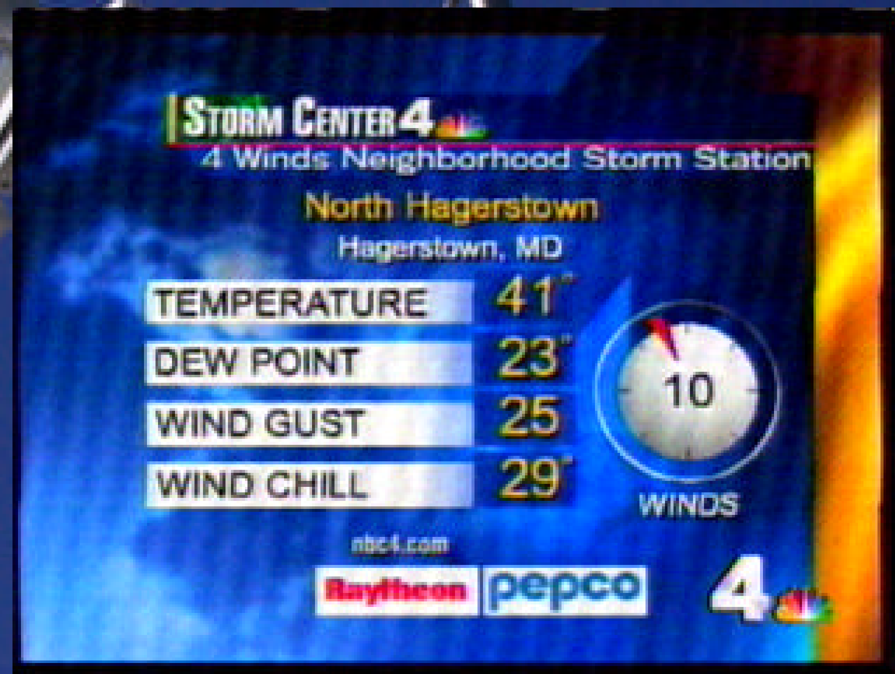


NBC 4
WASHINGTON, D.C.


STORM CENTER 4
LOCALIZED DATA IN NEIGHBORHOODS
STORM CENTER 4 Temps
4-WINDS Neighborhood Storm Stations
Accident
Boonsboro
39
Winchester
35
Gaithersburg
42
Annapolis
Washington 47
Milford
47
Sperryville 47
42
Waldorf
Bealeton 48
43
Leonardtown
51
Ocean City
50
Spotsylvania
47
pepco
4
STORM CENTER 4 Temps
4-WINDS Neighborhood Storm Stations
Seneca Valley HS
46
Johns Hopkins APL
48
NBC4
50
Naval Academy
49
Fairfax HS
47
Queen Anne MS
49
Jennie Dean ES
47
Thomas Stone HS
48
Calvert MS
50
4
NBC4
WASHINGTON, D.C.

STORM CENTER 4

LOCALIZED DATA IN NEIGHBORHOODS



NBC 4
WASHINGTON, D.C.

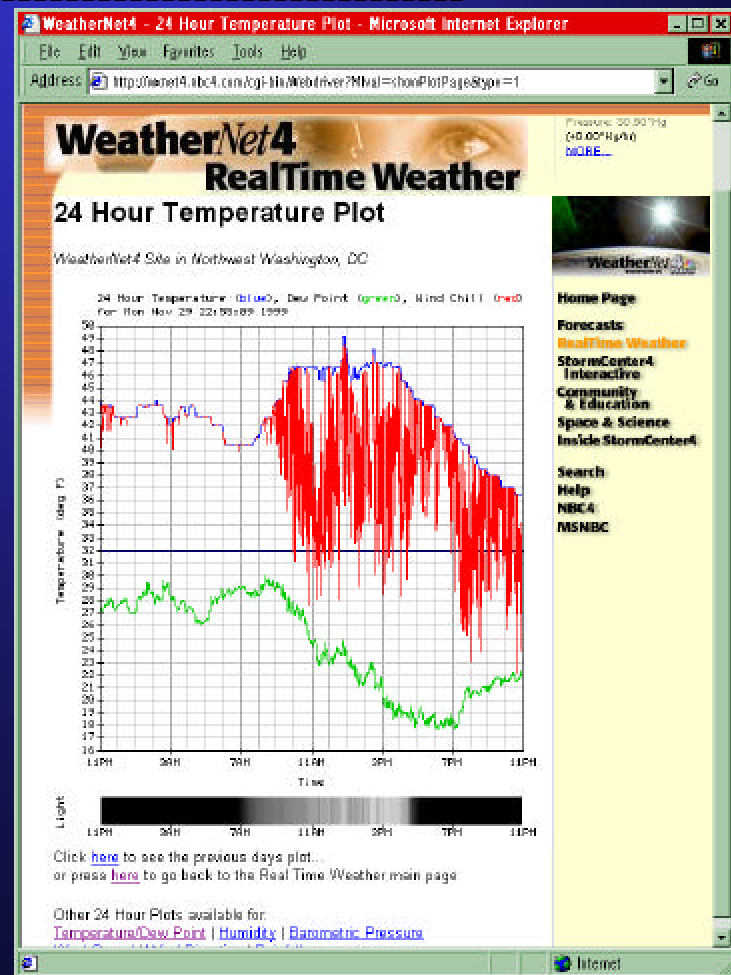
INTERNET APPLICATIONS OPEN THE DOORS TO GET MORE LOCALIZED

NBC4 Web Site - WeatherNet4

REAL-TIME CONDITIONS

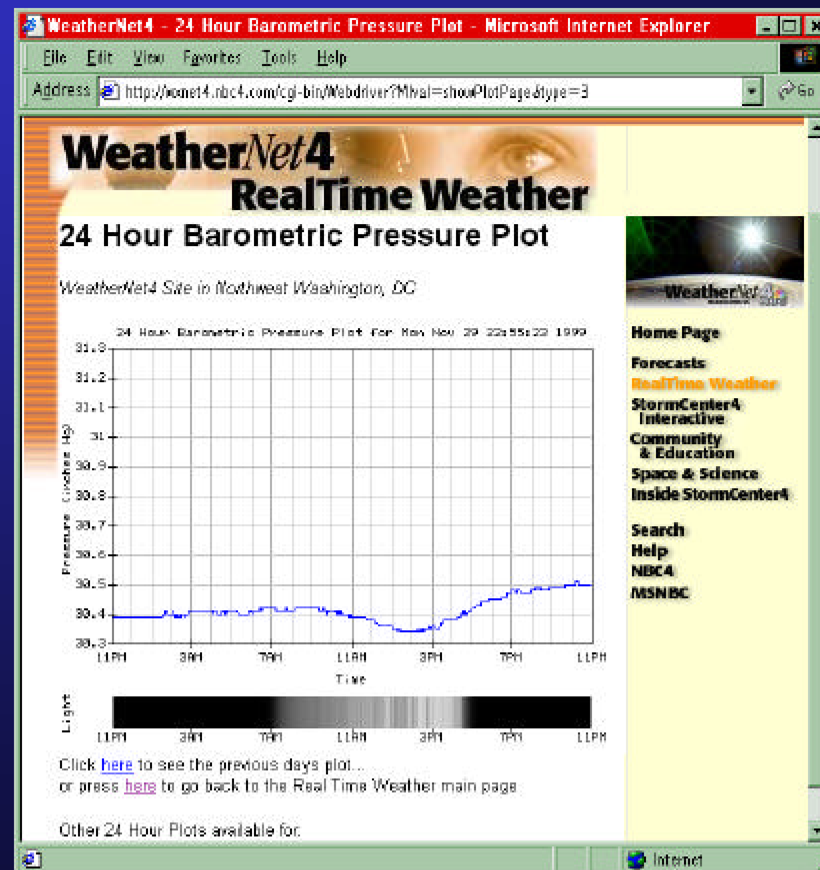
Real-Time Graphs

NBC4 Web Site - WeatherNet4



Real-Time Graphs

NBC4 Web Site - WeatherNet4



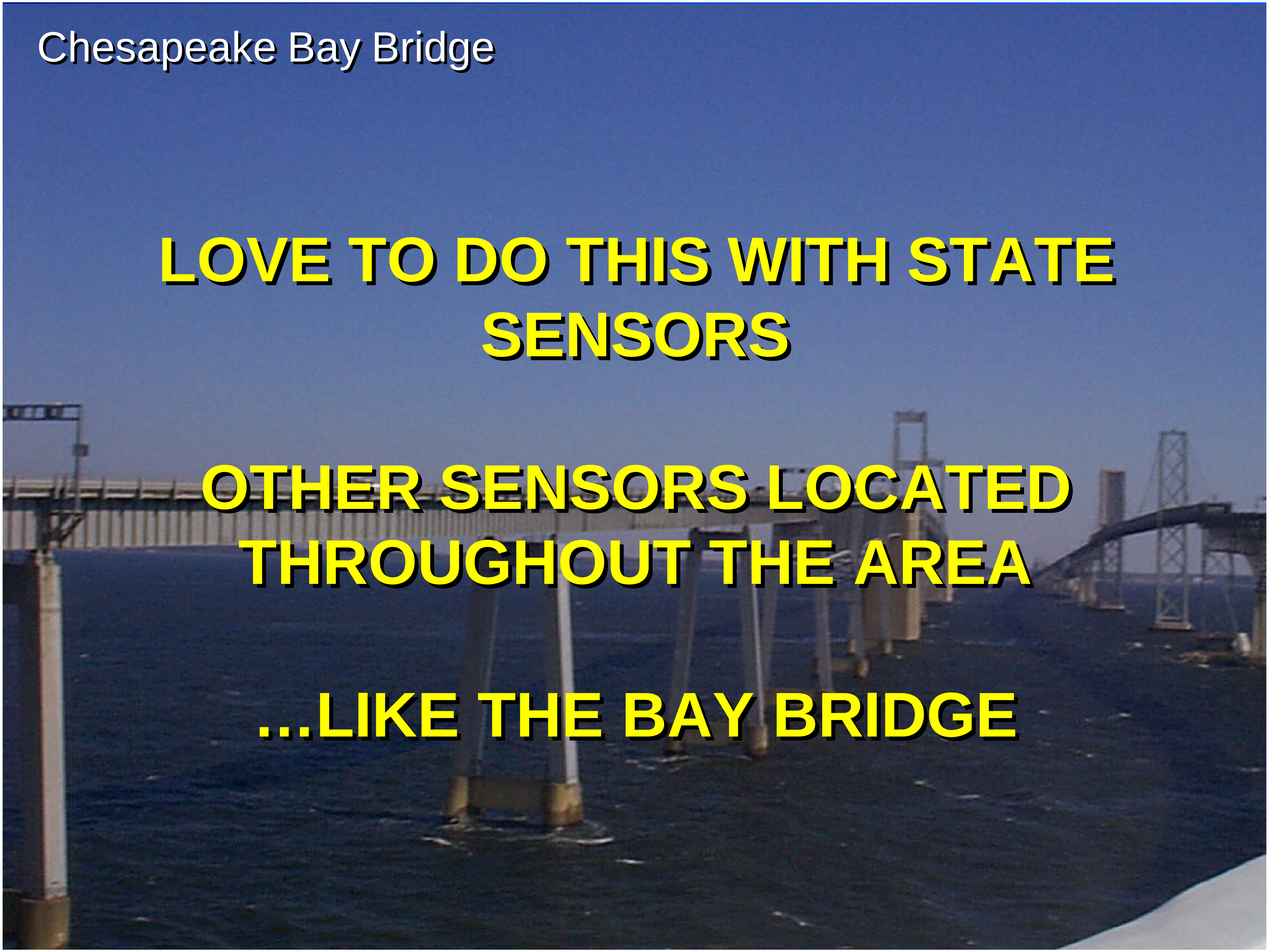
STORM CENTER 4

SERVING THE PUBLIC

LOVE TO DO THIS WITH STATE SENSORS

OTHER SENSORS LOCATED THROUGHOUT THE AREA

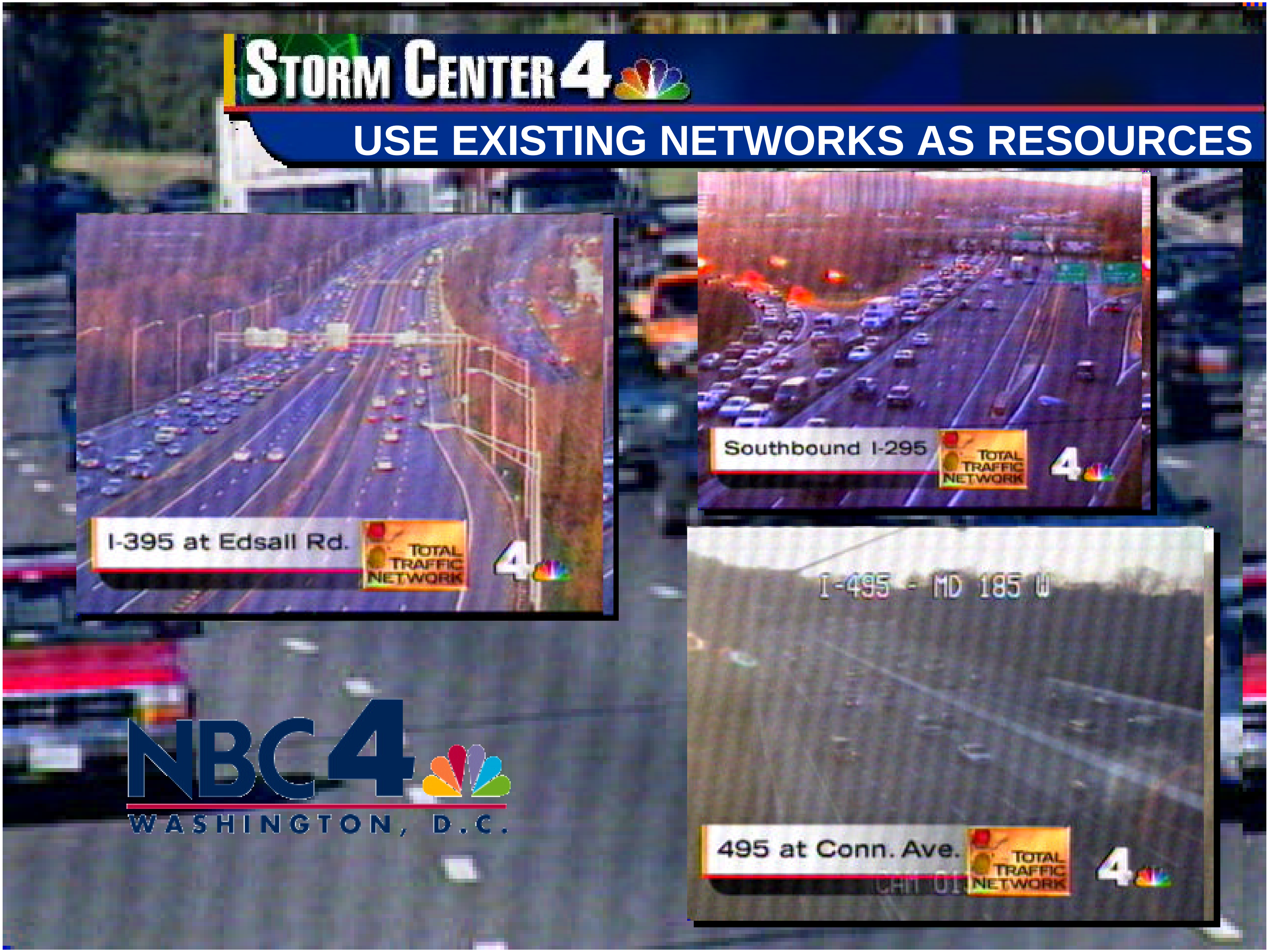
NBC 4
WASHINGTON, D.C.


Chesapeake Bay Bridge
LOVE TO DO THIS WITH STATE SENSORS
OTHER SENSORS LOCATED THROUGHOUT THE AREA
…LIKE THE BAY BRIDGE

STORM CENTER 4

LOCALIZED FORECASTS

NBC 4
WASHINGTON, D.C.


STORM CENTER 4
USE EXISTING NETWORKS AS RESOURCES
I-395 at Edsall Rd.
TOTAL TRAFFIC NETWORK
Southbound I-295
TOTAL TRAFFIC NETWORK
I-495 - MD 185 W
495 at Conn. Ave.
TOTAL TRAFFIC NETWORK
NBC4
WASHINGTON, D.C.

INTERNET APPLICATIONS OPEN THE DOORS TO GET MORE LOCALIZED

NBC4 Web Site - WeatherNet4

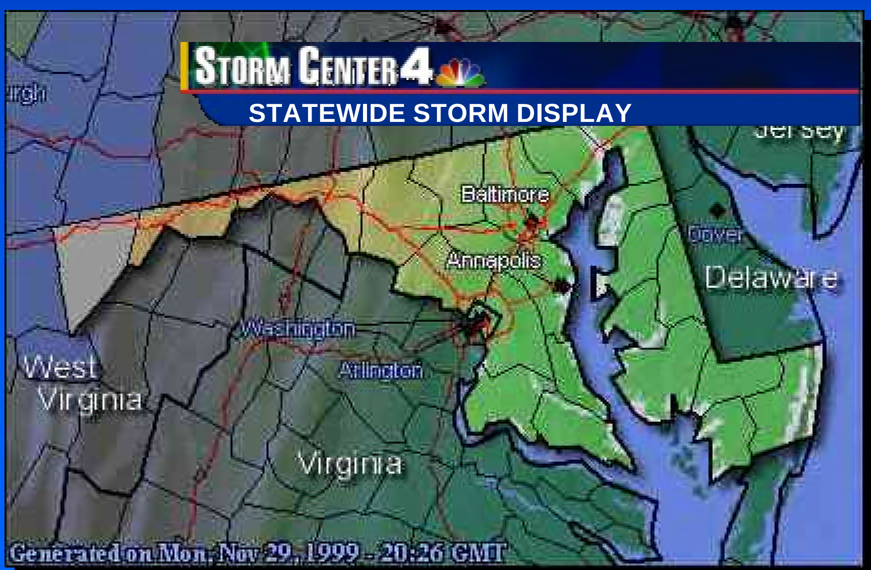
- WeatherNet4
  - Real-Time Data
  - Forecasts
  - E-Mail Delivery / Alerting
  - Specific Information
  - Wireless Updates

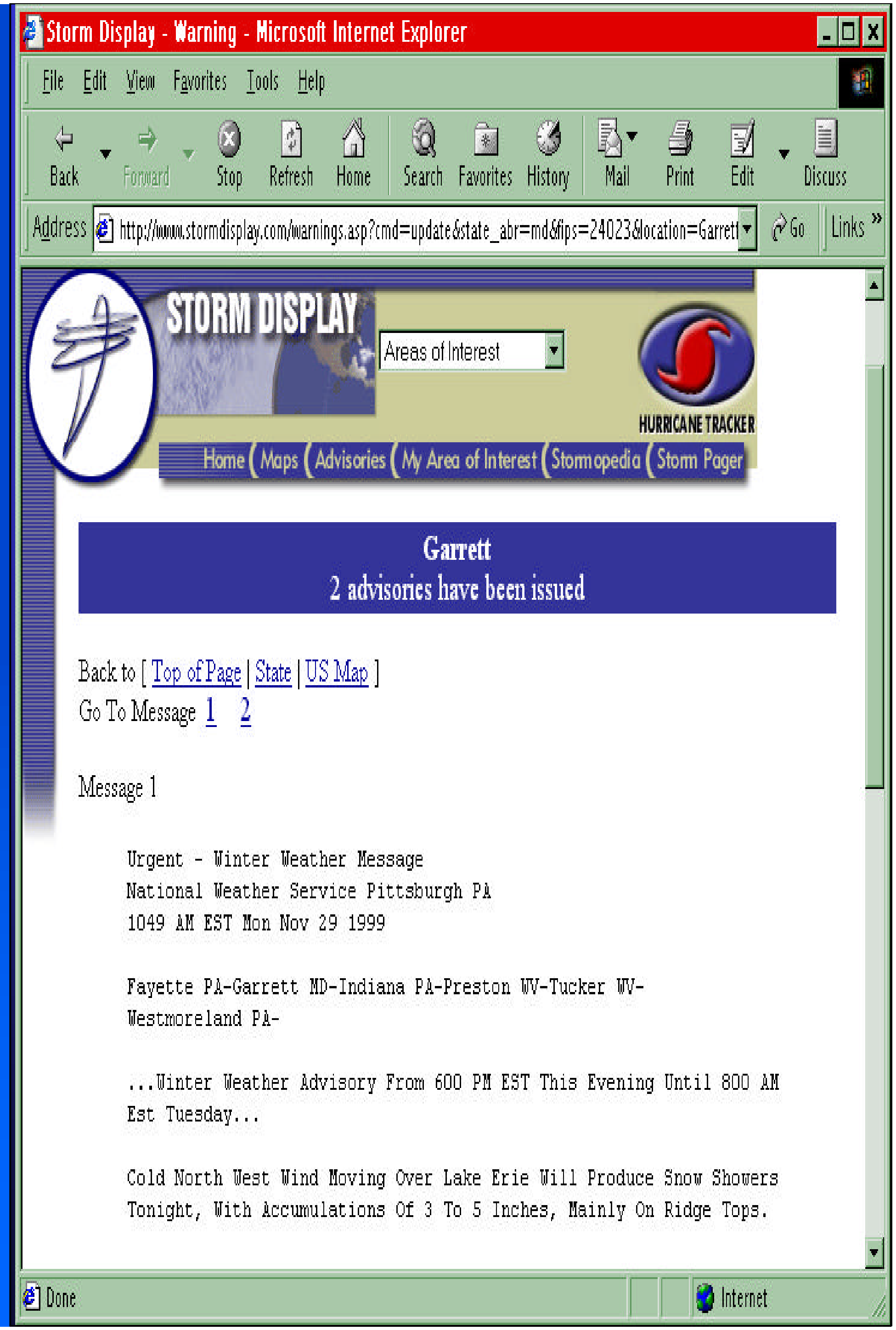
Increasing Science Data Relevance & Use

NBC4 Web Site - WeatherNet4

- My StormCenter
  - Live Data
  - Real-Time Satellite Imagery
  - Forecasts
  - Real-Time Storm Advisories


STORM CENTER 4
STORM DISPLAY
Generated on Mon, Nov 29, 1999 - 20:28 GMT


STORM CENTER 4
STATEWIDE STORM DISPLAY
Baltimore
Annapolis
Dover
Delaware
Washington
Arlington
West Virginia
Virginia
Generated on Mon, Nov 29, 1999 - 20:26 GMT


Storm Display - Warning - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss
Address http://www.stormdisplay.com/warnings.asp?cmd=update&state_abr=md&fips=24023&location=Garrett
Go Links
STORM DISPLAY
Areas of Interest
HURRICANE TRACKER
Home Maps Advisories My Area of Interest Stormopedia Storm Pager
Garrett
2 advisories have been issued
Back to [Top of Page | State | US Map]
Go To Message 1 2
Message 1
Urgent - Winter Weather Message
National Weather Service Pittsburgh PA
1049 AM EST Mon Nov 29 1999
Fayette PA-Garrett MD-Indiana PA-Preston WV-Tucker WV-
Westmoreland PA-
...Winter Weather Advisory From 600 PM EST This Evening Until 800 AM
Est Tuesday...
Cold North West Wind Moving Over Lake Erie Will Produce Snow Showers
Tonight, With Accumulations Of 3 To 5 Inches, Mainly On Ridge Tops.
Done
Internet

STORM CENTER 4

CONCLUSION

The more data and information we can collect on the conditions of our roads, the more effective we can be as communicators of today's and tomorrow's weather.

Value-Added Pointcasting in an information-crazed society!


Dave.Jones@nbc.com

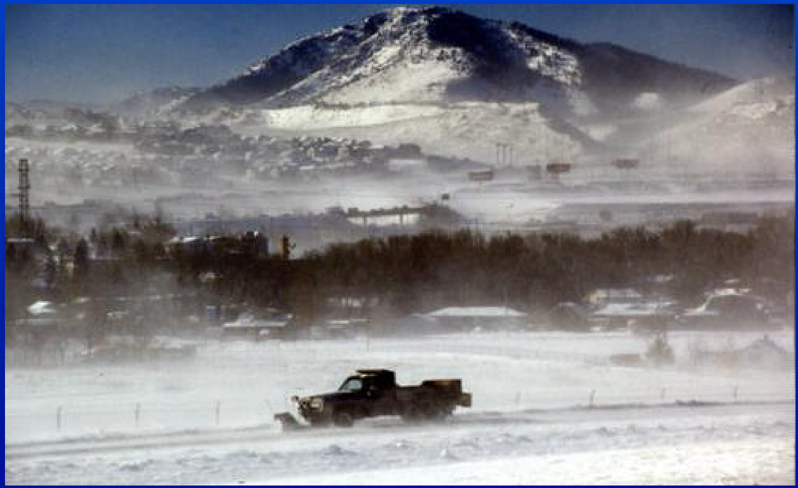
Federal Agency Weather Information Needs and Requirements

Federal Highway Administration

Paul Pisano

Weather & Winter Mobility Coordinator

Office of Transportation Operations



Presentation overview

FHWA &
the Weather

Info. Needs
Fulfilled to Date

Next Step -
Requirements

Optimizing performance through road weather information that is tailored for surface transportation decision makers.

#1

FHWA & the Weather

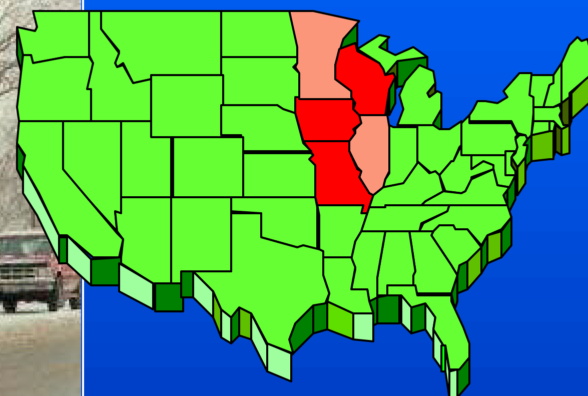
Why FHWA is involved

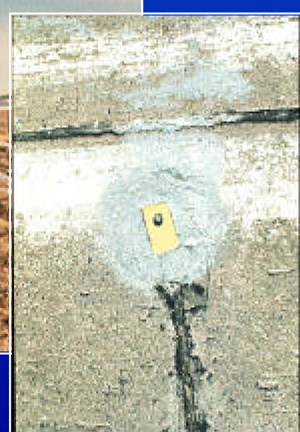
- Conduct R&D with State DOT partners
- Serve as catalysts and advocates to promote a nationally consistent and effective transportation system
- Serve as the liaison to other Federal agencies on behalf of our customers

#2

Information Needs Fulfilled to Date

Road Weather Information Systems (RWIS)

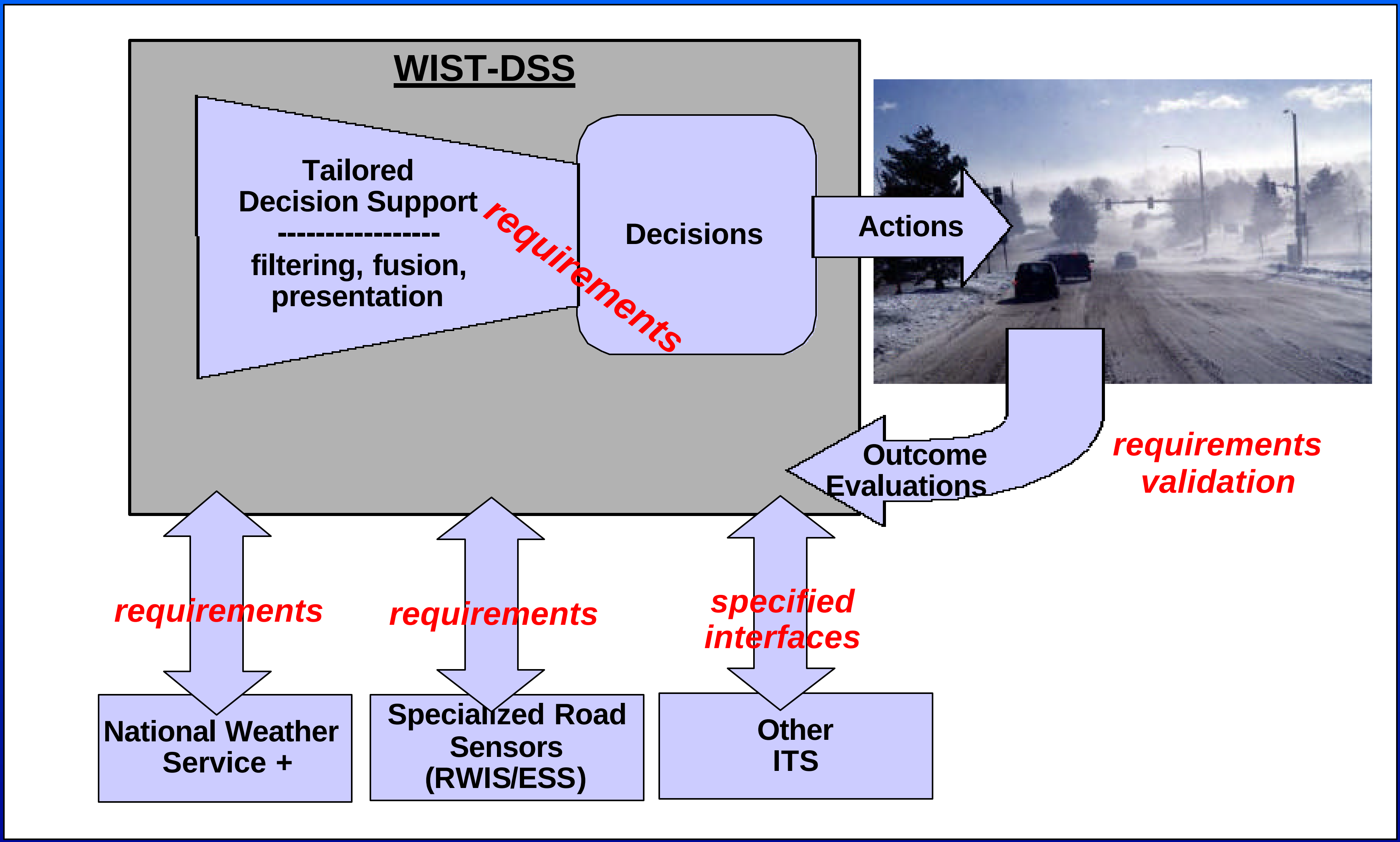




#3

Next Step - Requirements

Requirements within Surface Transportation Decision Support



Capturing the Needs

		Micro-Scale	Meso/Synoptic	Synoptic/Climatic
D M #	Need#	Warning	Operational	Planning
1.0	Infrastructure Operators			
1.1	Highway maintainer (winter)			
	1.1	control spreader application		
	1.2	control plow		
	1.3	control static (bridge) deicer		
	1.4	observe/report		
	1.5	navigate spreader/plow truck		
	2.1		detect/monitor weather event	
	2.2		schedule crews (split shifts)	
	2.3		prepare equipment	
	2.4		mix/load/replenish expendables	
	2.5		dispatch crews	
	2.6		program treatment control	
	2.7		repair/adjust equipment	
	2.8		coordinate (e.g., traffic mgt.)	
	2.9		request resource aid	
	2.10		dispatch damage repair	
	3.1			devise response plan
	3.2			hire staff
	3.3			train staff
	3.4			buy equipment/services
	3.5			stock stores
	3.6			budget
	3.7			schedule seasonal tasks
	3.8			calibrate treatment controls

Stakeholder Review Process

NOAA LABS	DOD LABS	University Consortium
Forecast Systems Lab (FSL)	Army Cold Regions Research and Engineering Lab (CRREL)	National Center for Atmospheric Research (NCAR)
Environmental Technology Lab (ETL)	Air Force/MIT Lincoln Laboratory	
National Severe Storms Lab (NSSL		

U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU.

CHARLES F. MARVIN, Chief.

New England Highway Weather Bulletin.

BOSTON, MASS., *March 31, 1920.*

For New England: Continued thawing weather, with probability of showers by Friday night, will further open the routes still closed to motor traffic in mountain sections of northern New England and western Massachusetts.

Motorists are advised to travel only on surfaced, improved highways; dirt roads are rough and muddy, and in hill districts are blocked with drifts.

Subscription at 50 cents per year. Mail money order or New York draft to Superintendent of Documents, Government Printing Office, Washington, D. C. Send copy only of your letter to this office.

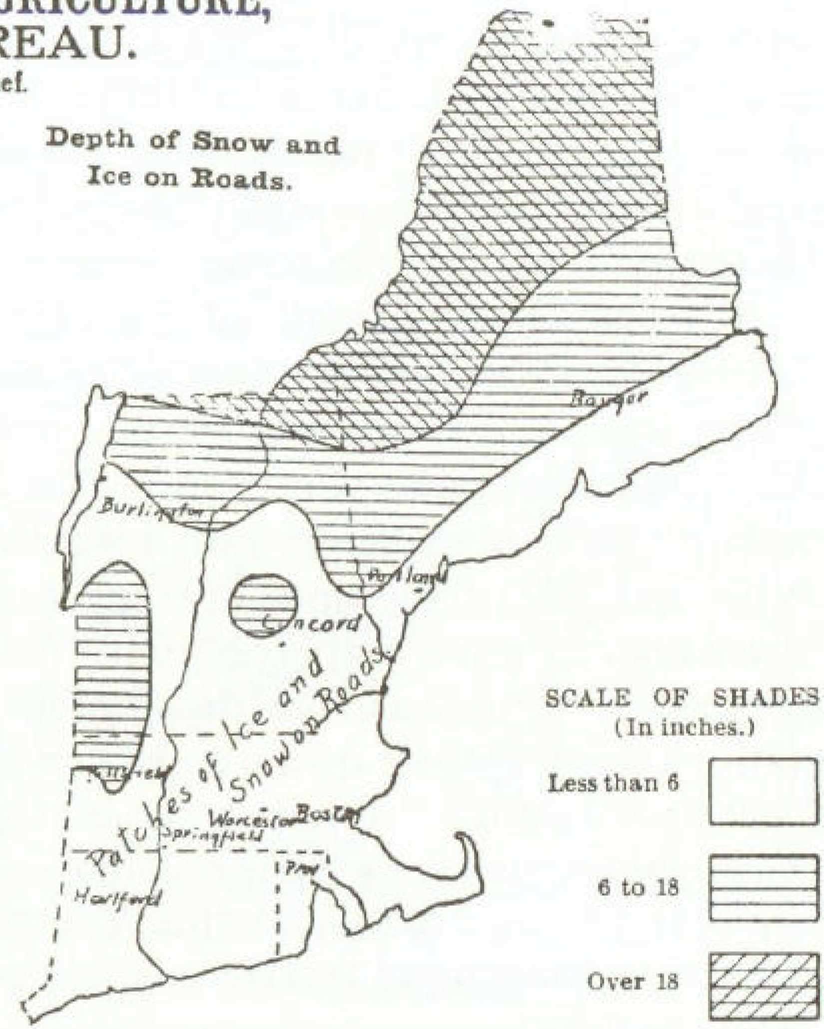


Fig. 9.5 from Air Apparent, Mark Monmonier, U. Chicago Press, 1999

Weather Issues and Needs for Railroads

Michael Rossetti
USDOT/RSPA/Volpe Center
(Representing the FRA)

OFCM Symposium on Weather Information for Surface Transportation, 12/1/99

Weather Events Affecting Railroad Operations

- Crosswinds/high winds
- Hurricanes
- Tornadoes
- Flash floods and washouts (Arizona)
- River flooding (1993 Midwest)
- Mudslides
- Sun kinks, track buckling -derailments (Aug. 1998 Texas)

- Rate of change of track temperature
- Brittle track (winter cold)
- Snowstorms
- Avalanches
- Mode shifts during extreme weather (Amtrak '96 blizzard)
- Fog: depth and duration
- Lightning (June 1999 CSX)
- Catenaries(winter icing, summer heat sag)
- Cold weather - air brake freeze-up

Current Weather Information Used by Railroads

- Almost all types of weather info
- Used for both seasonal planning and short term operating decisions
- Operating procedures linked to weather events
- Services provided by commercial meteorologists

Future Weather Information Needs and Roles for Railroads

- As a Provider
  - Wayside bungalows - data collection
  - Railroads building data networks
  - Trains as mobile weather data collection platforms
- As a User
  - Railroads make operational decisions. FRA only monitors impacts
  - Better hydro models data and QPF for floods/flash floods
  - Better 3 month/seasonal forecasts
  - Higher resolution (time and space) short term forecasts
  - Other environmental (earthquakes, wind fields/dispersion)

TRANSIT WEATHER INFORMATION REQUIREMENTS

Arthur L. Handman
Greater Hartford Transit District
Representing
Federal Transit Administration

2/28/00

TYPES OF TRANSIT SYSTEMS

- Rural (Bus and Paratransit)
- Urban:
  - Bus/Paratransit
  - Metro (Heavy Rail)
  - Light Rail
- Commuter Rail

WEATHER INFORMATION NEEDS

- At Gathering Stage (WIATSF of ITS efforts)
- Needs vary by user

SPECIFIC WEATHER PARAMETERS

- Freezing rain affects traction
- Fog affects visibility
- Snowfall rate and accumulation
- Temperature gradient/area
- Severe storm location

DECISION TIMING CRITICAL

- When is action required?
- What is forecast warning period?

WHO MAKES DECISION?

- Determines type and format of weather data
- Determines where weather information is sent

FEEDBACK

- Sensors on vehicles with MDTs
- Operator/Supervisor Observations

CURRENT STATUS

- Public/private reports
- Spot observations
- Internet (Weather Channel, e.g.)
- No standards for gathering or processing
- No standard decision matrix
- No standard instrumentation system architecture

UNIQUE EXPERIENCES/COST IMPACT

- Tornado destroyed bus - $45,000 to replace
- Annual weather related damage claims - $25,000
- Schedule delays - $1,150 per hr.

FUTURE NEEDS

- Gather and standardize transit industry weather information needs
- Develop decision matrixes
- Develop system architecture
- Train users

Weather Information for Surface Transportation

Department of Energy

National Transportation Program

Transportation Activities

- DOE Strategic Goal - Environmental Quality
  - Disposal of Radioactive Waste
  - Safely Manage Nuclear Materials
  - Safely Manage Spent Fuel
- National Transportation Program
  - Ensure Safe and Compliant Transportation

Transportation Operational Contingencies

- Determinations of acceptable weather conditions
  - Carrier decision
  - Shipper and Carrier Decision
- Requirements to Support Decisions
  - Before Dispatch
  - In-route

Specific Weather Needs

- Severe Weather Conditions
  - Winter Storm/Heavy Snow
  - Thunderstorm Warning
  - Tornado Warning
- Adverse Road Conditions
  - Heavy Fog
  - High Wind
  - Flash Flood
  - Freezing Rain
  - Blowing & Drifting Snow

Operational Application Needs

- Risk Assessments

  RADCALC

  - Air Stability Class
  - Wind Direction/Speed
  - Information Tied to Major Transportation Routes

- In-Route Tracking

  TRANSCOM

  - Overlay Severe Weather Warnings

How Did We Get Here?

- Any relevant historical information
- Original assumptions that are no longer valid

Available Options

- State the alternative strategies
- List advantages & disadvantages of each
- State cost of each option

Recommendation

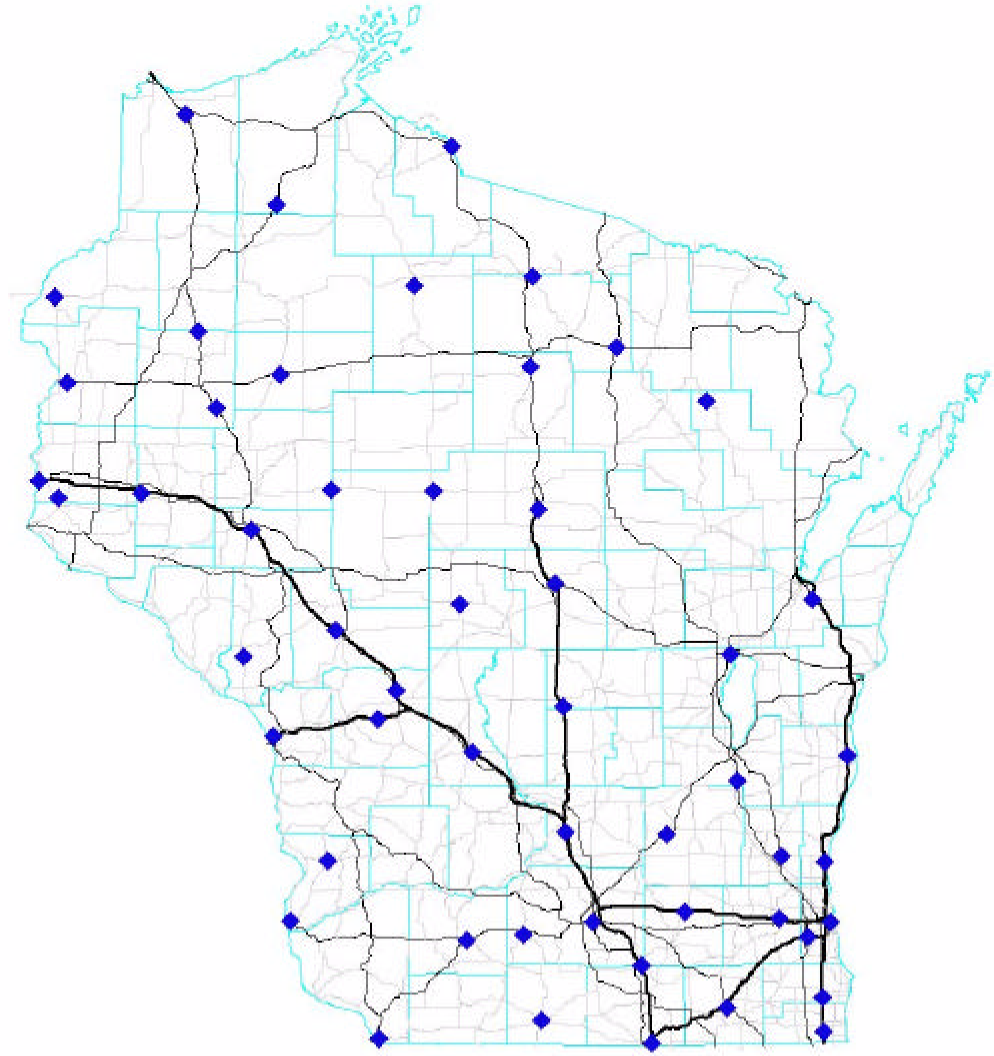
- Recommend one or more of the strategies
- Summarize the results if things go as proposed
- What to do next
- Identify Action Items

THE WISCONSIN ROAD WEATHER INFORMATION SYSTEM (RWIS)

Mike Adams

WisDOT RWIS Program Manager

THE WISCONSIN RWIS NETWORK



ROAD MAINTENANCE IN WISCONSIN

- DOT doesn’t actually perform maintenance
- Contracts with each county to maintain state and federal highways

WEATHER FORECAST SERVICES

- Key issues addrssed in forecast contract
  - Timeliness (2:30 AM, 2:00 PM)
  - Lead time (4 hours before snow starts)
  - Keyed to specific criteria
    - Snow amount $\geq$ 2 inches
    - Freezing precipitation
    - Pavement temperature $\leq 32^{o}$F
    - Frost
  - Satellite delivery via DTN

WEATHER FORECAST SERVICES

- Toll-free access to forecaster
- Pavement temperature forecast for all 52 sensor sites
- Storm warning services

WEATHER FORECAST SERVICES

- Important in <u>proactive</u> anti-icing operations
- Advance warning, timing error are critical
  - Need to know well before storm hits
  - Need to know exactly when precipitation will start
  - Need to know likelihood of frost

CHALLENGES

- Lack of infrastructure through which to transmit and share information
- Data dissemination to 72 counties
- Forecast accuracy
- System maintenance
- Proprietary products and services
- Integration with other weather data sources
- What information to provide to public...
- ...And how to provide it

[redacted]

FORETELL

Integrating
Intelligent Transportation Systems
With
Advanced Weather Prediction

Dean Deeter, P.E.

Structure

- Overview of FORETELL
- Progress to Date
- Next Steps
- Screen Shots

Users

- Maintenance Operators and Dispatchers
  - Weather and Road Condition Forecasts
  - 24 Hour Forecasts
  - Easy Access to Information
  - View multiple types of information simultaneously

Users

- Travelers
  - Driving conditions
    - Open or Closed?
    - Conditions
  - Weather conditions
    - Along route and at destination

FORETELL Concept

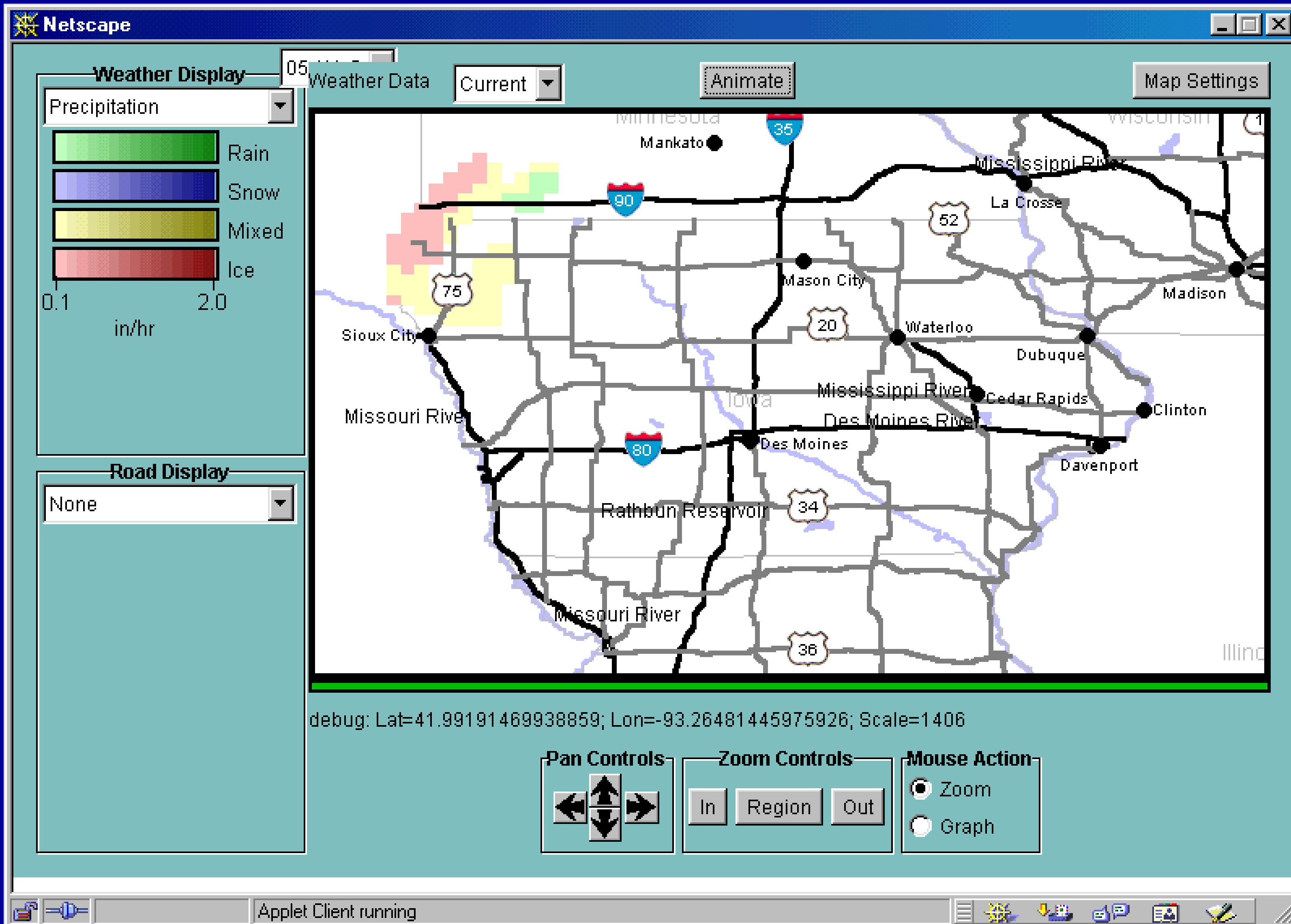
- Atmospheric Modeling
- Road Condition Modeling
- In-field Sensors (Fixed and Mobile)
- Condition Reports (Situations)
- Graphic Displays
- Phone / Fax / e-mail

Current Status

- 1998/1999 Winter
  - Models Developed and Data Collected
  - Demonstrate 1st Version of Display
- 1999/2000 Winter
  - Kickoff
  - Operation in FORETELL States

Next Steps

- Decision Support for Maintenance Operators
- Expansion of Data Sources
- Expansion of Dissemination Area



Netscape
Weather Display
Precipitation
Rain
Snow
Mixed
Ice
0.1
2.0
in/hr
Weather Data
Current
Animate
Map Settings
Mankato
Mississippi River
La Crosse
Mason City
Madison
Sioux City
Waterloo
Dubuque
Mississippi River
Cedar Rapids
Clinton
Des Moines River
Des Moines
Davenport
Rathbun Reservoir
Missouri River
debug: Lat=41.99191469938859; Lon=-93.26481445975926; Scale=1406
Road Display
None
Pan Controls
Zoom Controls
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Region
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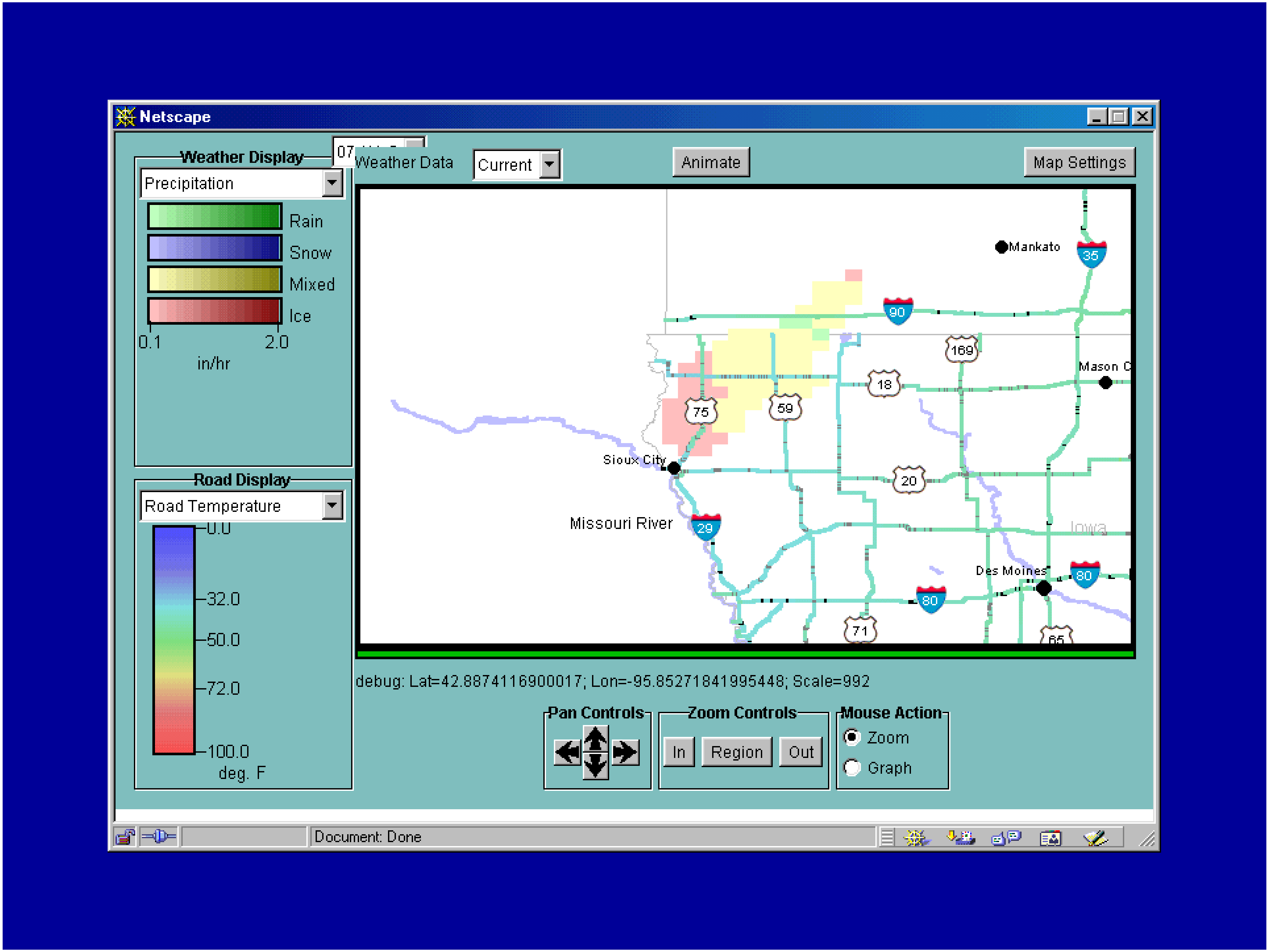
Mouse Action
Zoom
Graph
Applet Client running


Netscape
Weather Display
Precipitation
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Ice
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Road Display
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Des Moines
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Region
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Mouse Action
Zoom
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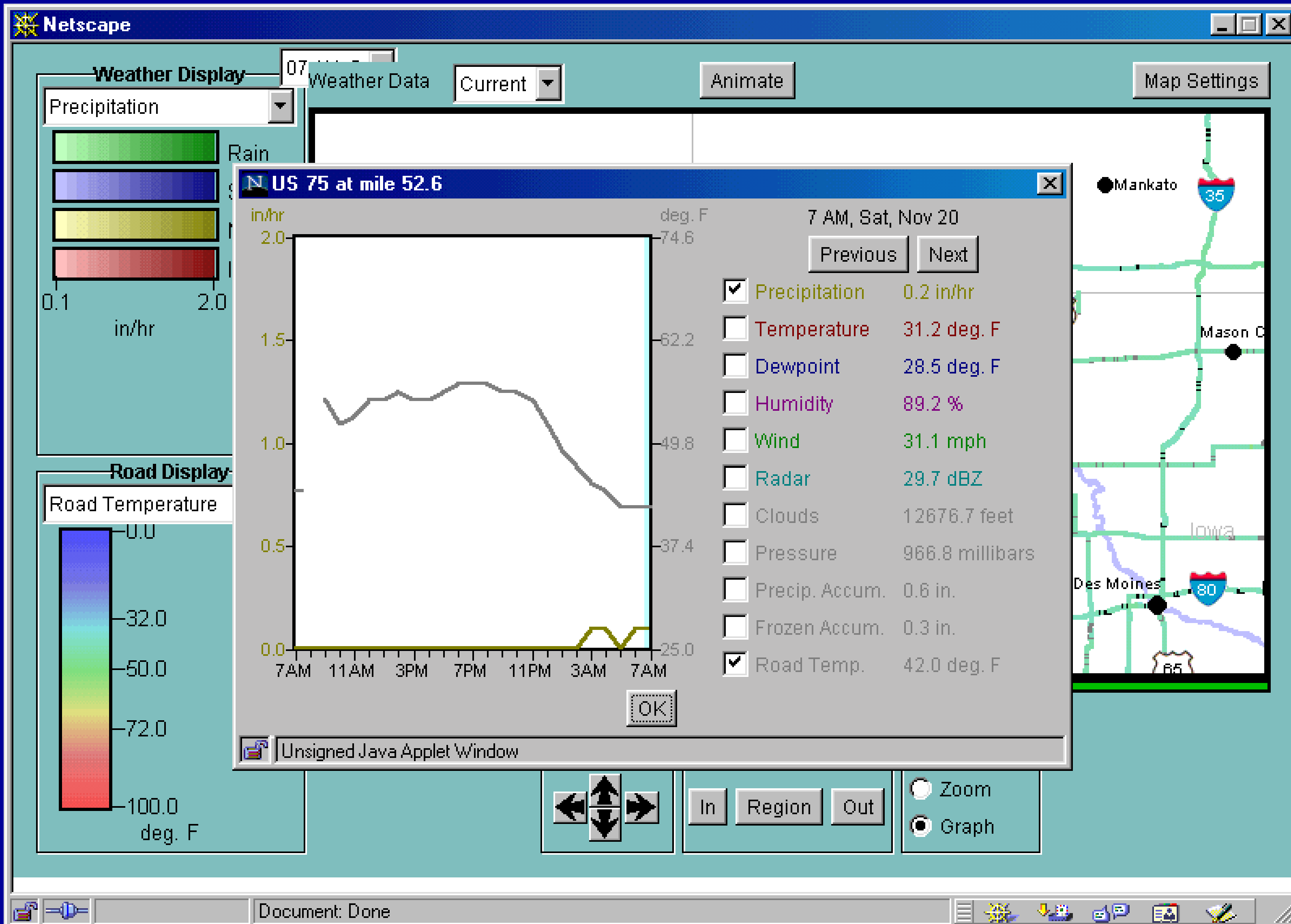
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Weather Display
Precipitation
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US 75 at mile 52.6
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74.6
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49.8
37.4
25.0
7AM
11AM
3PM
7PM
11PM
3AM
7AM
OK
7 AM, Sat, Nov 20
Previous
Next
Precipitation 0.2 in/hr
Temperature 31.2 deg. F
Dewpoint 28.5 deg. F
Humidity 89.2 %
Wind 31.1 mph
Radar 29.7 dBZ
Clouds 12676.7 feet
Pressure 966.8 millibars
Precip. Accum. 0.6 in.
Frozen Accum. 0.3 in.
Road Temp. 42.0 deg. F
Unsigned Java Applet Window
Mankato
35
Mason C
Iowa
Des Moines
80
65
Road Display
Road Temperature
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deg. F
In
Region
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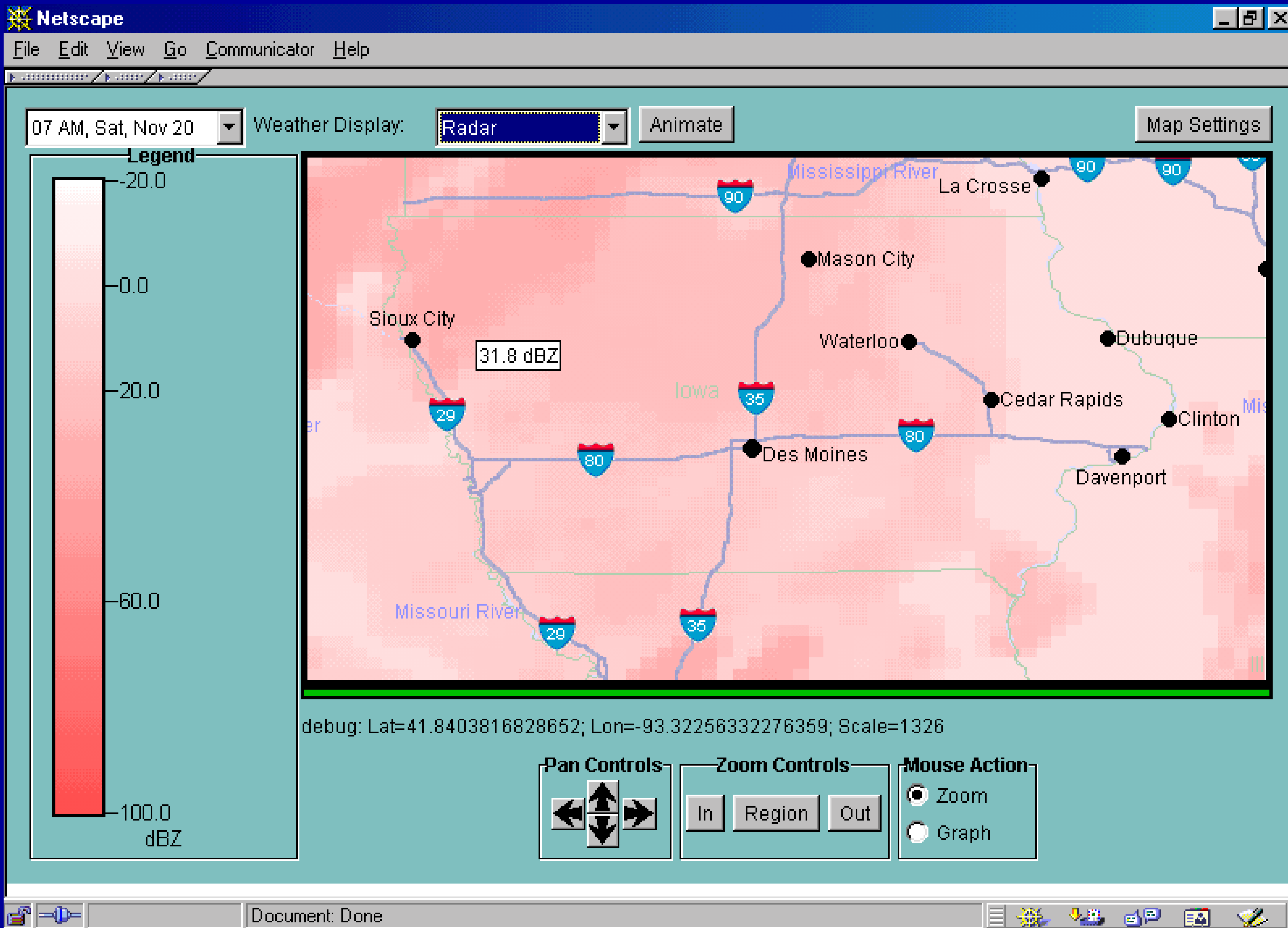
Zoom
Graph
Document: Done


Netscape
File Edit View Go Communicator Help
07 AM, Sat, Nov 20
Weather Display:
Radar
Animate
Map Settings
Legend
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60.0
100.0
dBZ
Mississippi River
La Crosse
90
Mason City
Sioux City
31.8 dBZ
Waterloo
Dubuque
Iowa
35
Cedar Rapids
29
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Clinton
Des Moines
Davenport
Missouri River
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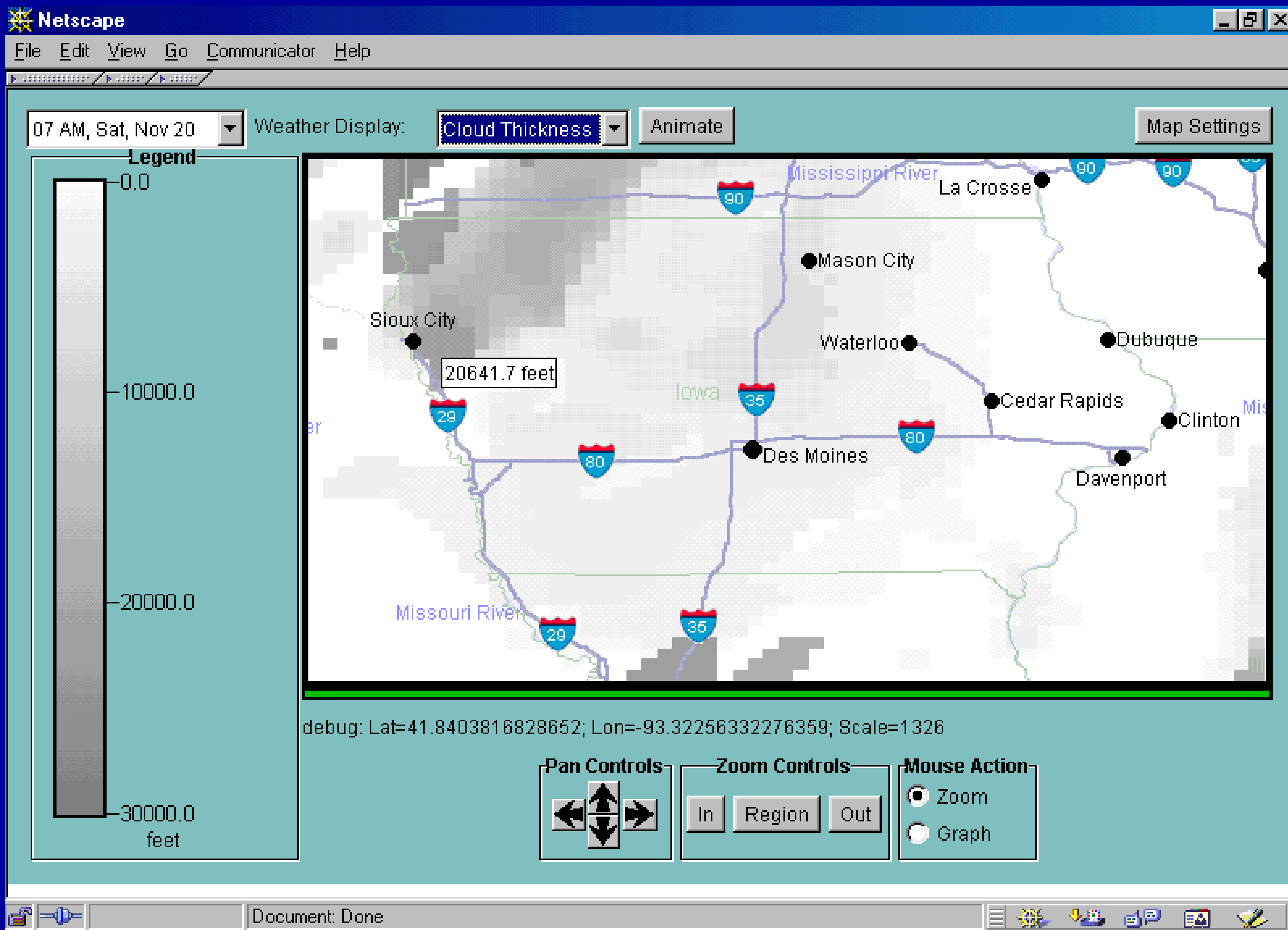

Netscape
File Edit View Go Communicator Help
07 AM, Sat, Nov 20
Weather Display:
Cloud Thickness
Animate
Map Settings
Legend
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10000.0
20000.0
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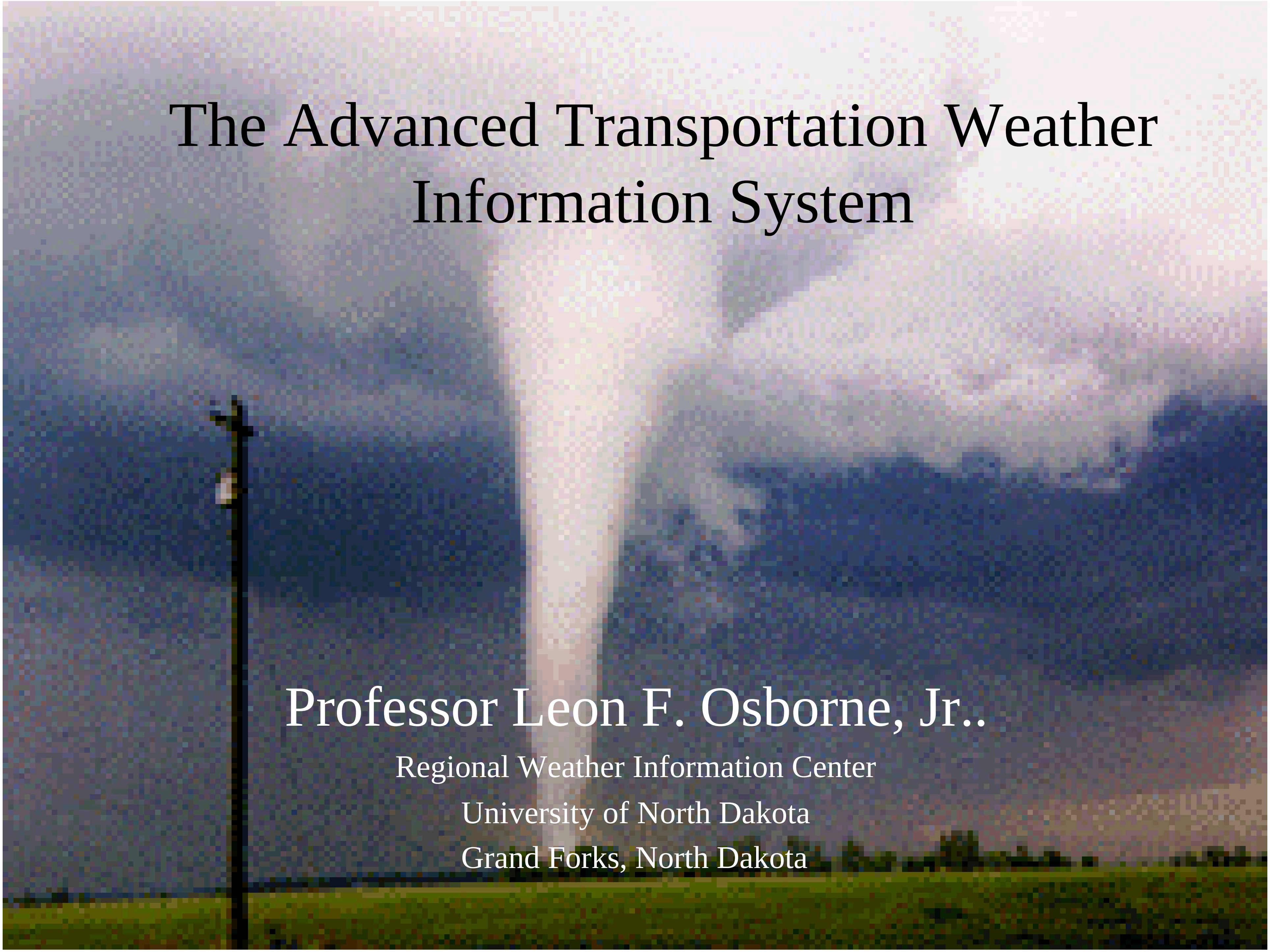
feet
Mississippi River
La Crosse
Mason City
Sioux City
Waterloo
Dubuque
20641.7 feet
Iowa
Cedar Rapids
Clinton
Des Moines
Davenport
Missouri River
90
35
29
80
debug: Lat=41.8403816828652; Lon=-93.32256332276359; Scale=1326
Pan Controls
Zoom Controls
In
Region
Out
Mouse Action
Zoom
Graph
Document: Done

Conclusions

- Needs Driven
- Maintenance and Travelers
- More Information:
  - John Whited IADOT (515) 239-1411



The Advanced Transportation Weather Information System

Professor Leon F. Osborne, Jr..

Regional Weather Information Center

University of North Dakota

Grand Forks, North Dakota

The Goal of ATWIS

To evaluate & demonstrate the effectiveness of mesoscale meteorological analysis and forecasting in providing safer and more efficient operations in an ATIS.

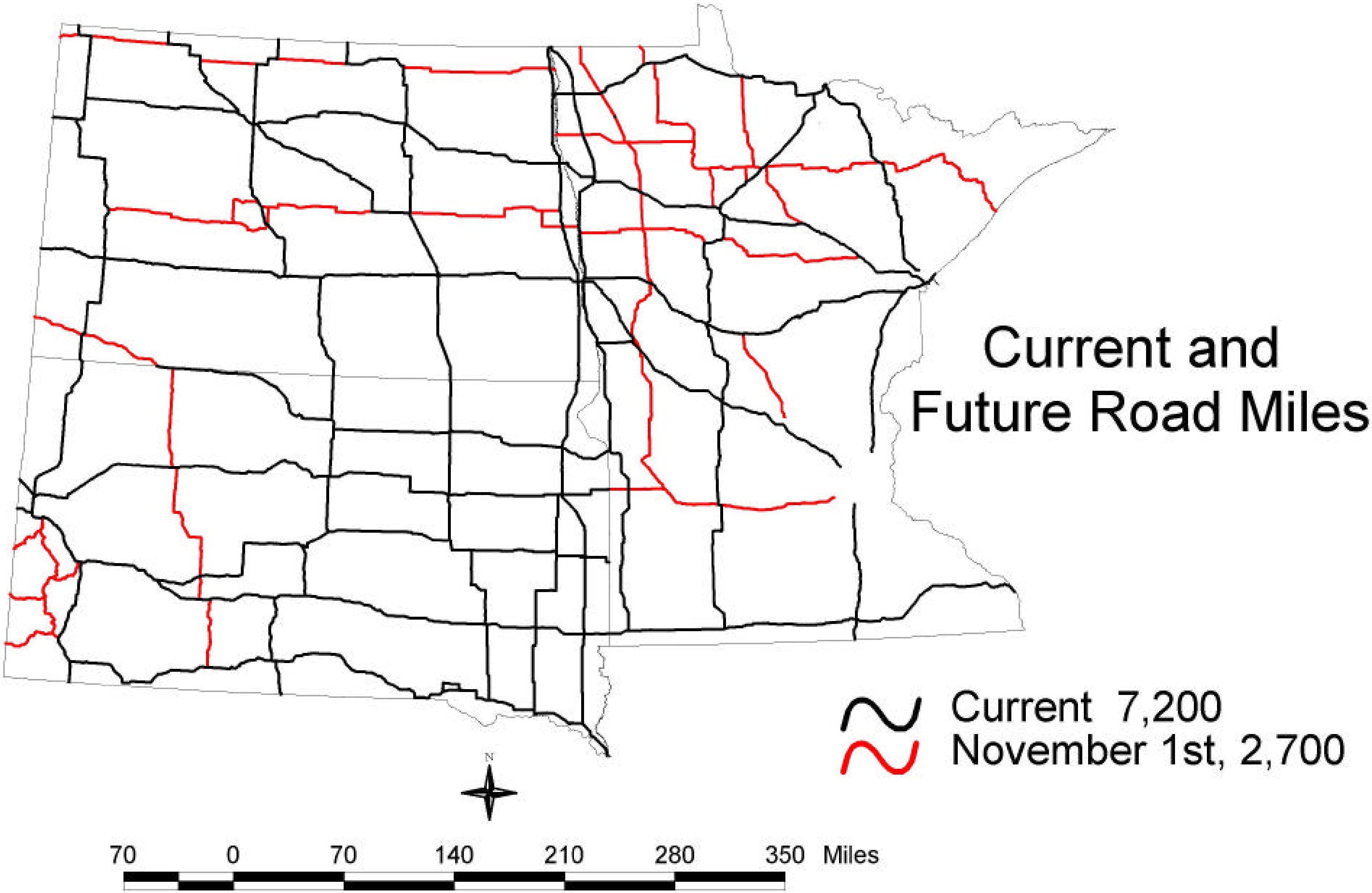
Precise spatial and temporal weather information
In-vehicle information distribution

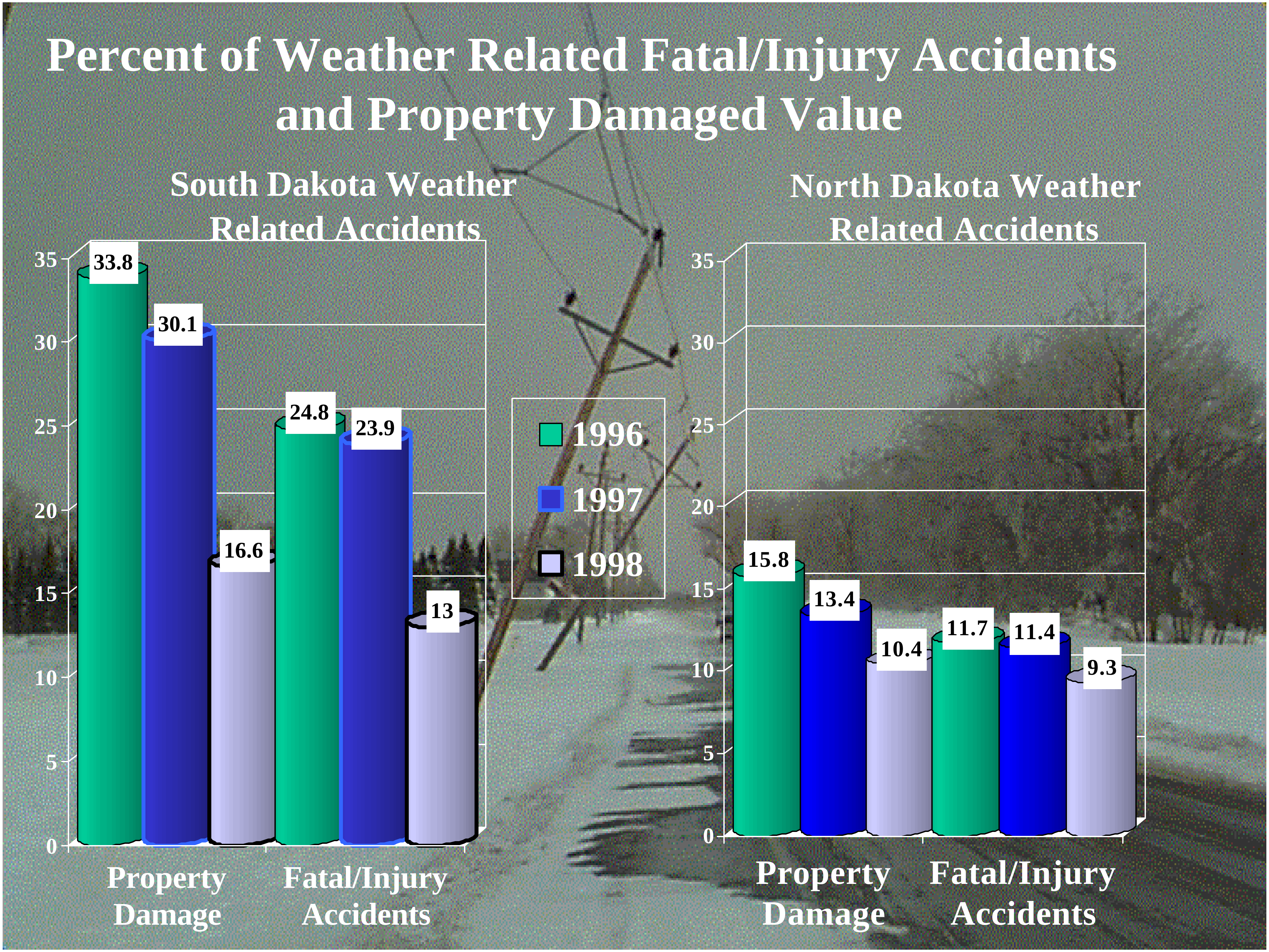
R & D Began	**17 July 1995**	
Operations Began	**30 Oct. 1996**	**2400 Road miles**
	1 Nov. 1997	**3700 Road miles**
	1 Nov. 1998	**4800 Road miles**
	14 Feb. 1999	**7200 Road miles**


Decision Support System
Decision Support System Development
Cross Discipline Integration
MM5 AWOS/ASOS RWIS
GOES NEXRAD LAPS
NWS Suite of Models
Efficiency - integrates information


Current Delivery Technology
Wireless Communication
Mass test population
Automate Telephony
Every Cellular Company
Started with 4 Expanded to 13
New Cellular Companies
Advances in Wireless Communication

#SAFE 1999-2000 Winter Driving Season




Percent of Weather Related Fatal/Injury Accidents
and Property Damaged Value
South Dakota Weather
Related Accidents
North Dakota Weather
Related Accidents
35
30
25
20
15
10
5
0
33.8
30.1
16.6
24.8
23.9
13
15.8
13.4
10.4
11.7
11.4
9.3
1996
1997
1998
Property
Damage
Fatal/Injury
Accidents

Traveler Comment Line

Local User Approx. 6.4 Million
Most Travelers are Multiple Users
Known Out of State Users Include

AL, ID, NE, CA, TX, CT, WI, WA, OR, MT, ON, AB, MB

5:33 PM Friday 8/27/99

This is Barbara, we live in Portland OR. We are traveling, we brought our daughter to Sioux Falls to go to college and we were so thankful for this weather service, because we were caught in, we got into a really bad thunder storm on the night of the 29th and we were able to project how we could travel or whether we should go on, so thank you very much, we appreciate and are so grateful for it so thank you.

For More Information Contact

REGIONAL WEATHER Information Center

P.O. Box 9007 Grand Forks, North Dakota 58202 701-777-2479

UND AEROSPACE

http://www.rwic.und.edu

Intelligent Road/Rail Information System

iris

Highways & Railroads for National Defense

For: Symposium on Weather Information for Surface Transportation

by:
Paul Allred
2 December 1999

Military Command Structure

Improve the deployability of the U.S. Armed Forces

U.S. Transportation Command

Military Sealift Command (Water)

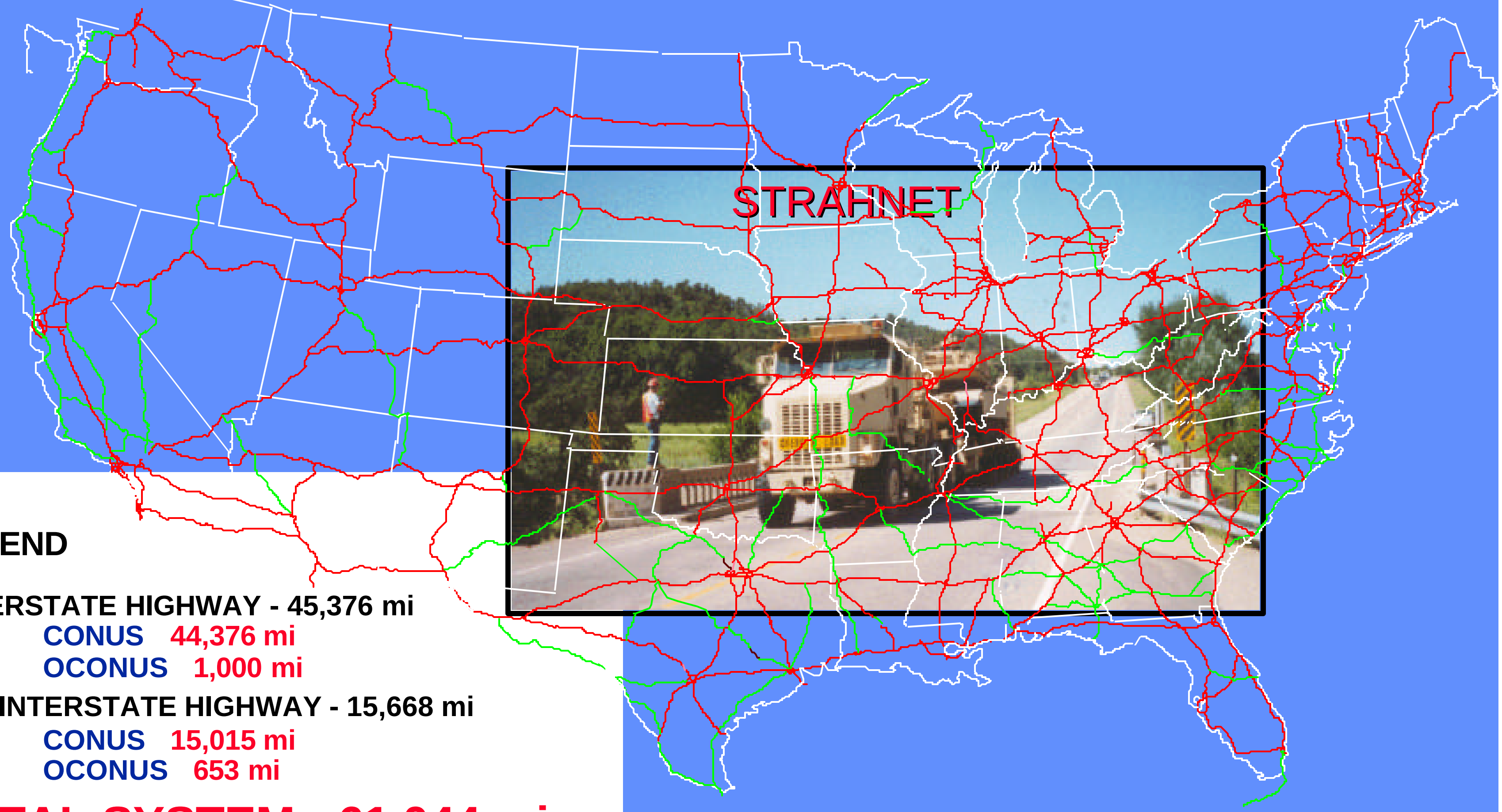
Military Traffic Management Command (Land)

Air Mobility Command (Air)

Transportation Engineering Agency (Land)

STRAHNET

Strategic Highway Network



LEGEND

INTERSTATE HIGHWAY - 45,376 mi
CONUS 44,376 mi
OCONUS 1,000 mi

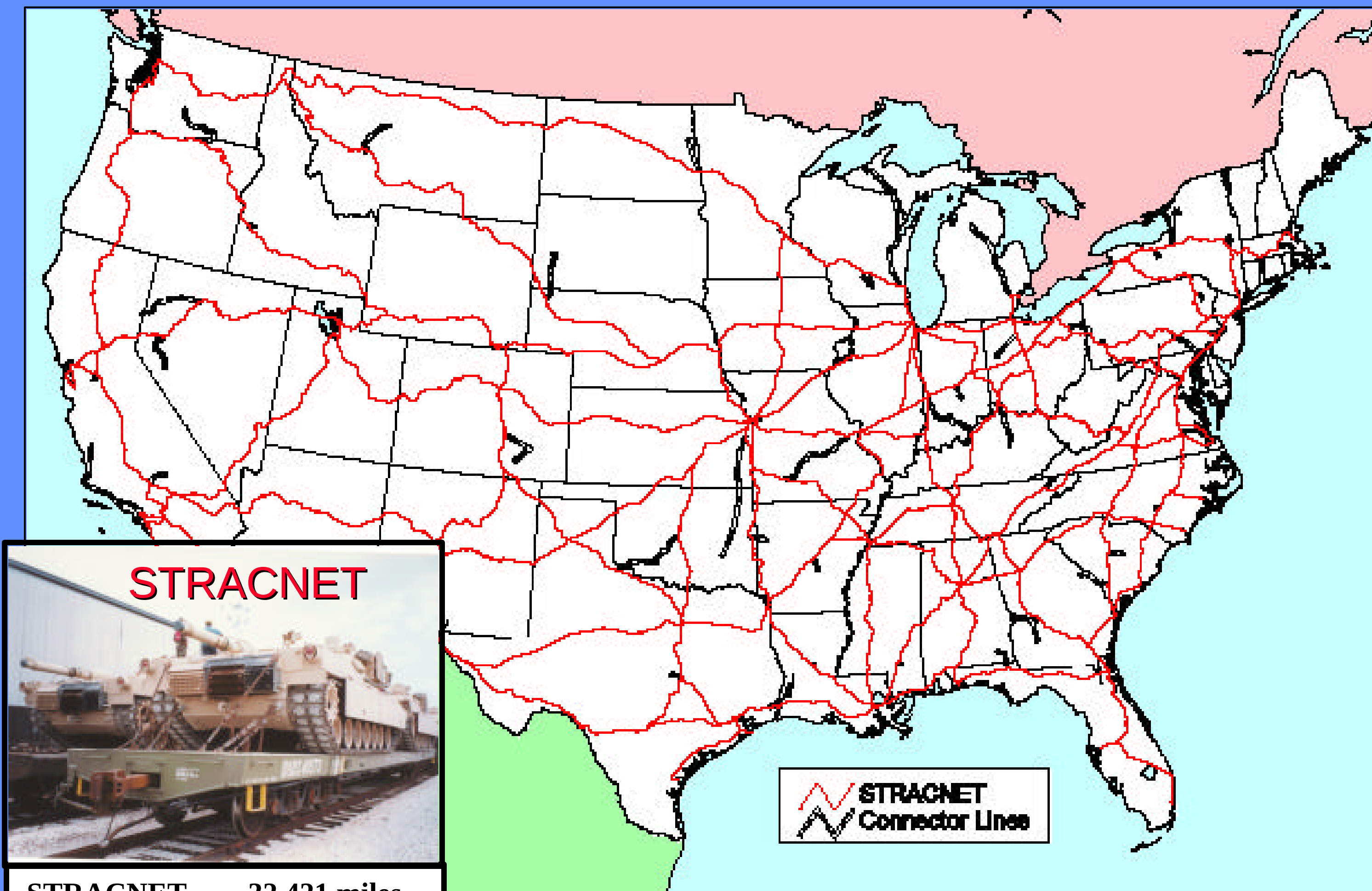
NONINTERSTATE HIGHWAY - 15,668 mi
CONUS 15,015 mi
OCONUS 653 mi

TOTAL SYSTEM - 61,044 mi

OCONUS INCLUDES ALASKA, HAWAII, & PUERTO RICO

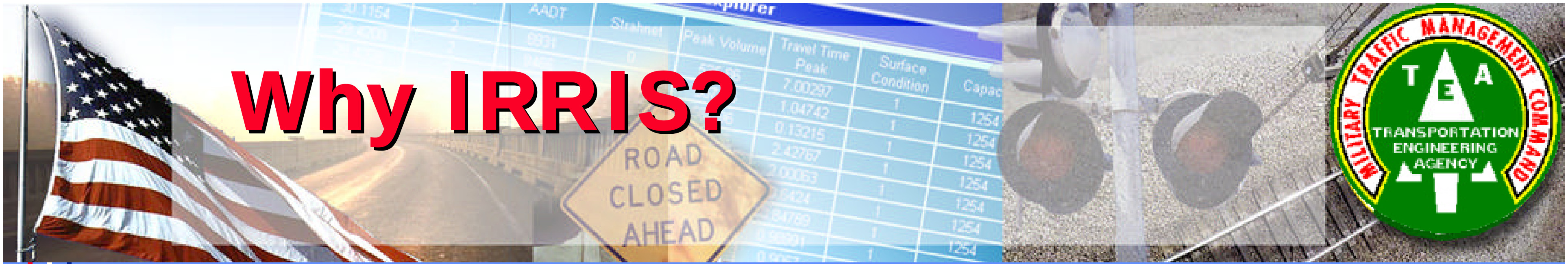
STRACNET

Strategic Rail Corridor Network



STRACNET - 32,421 miles
Connector Lines - 5,378 miles

Why IRRIS?

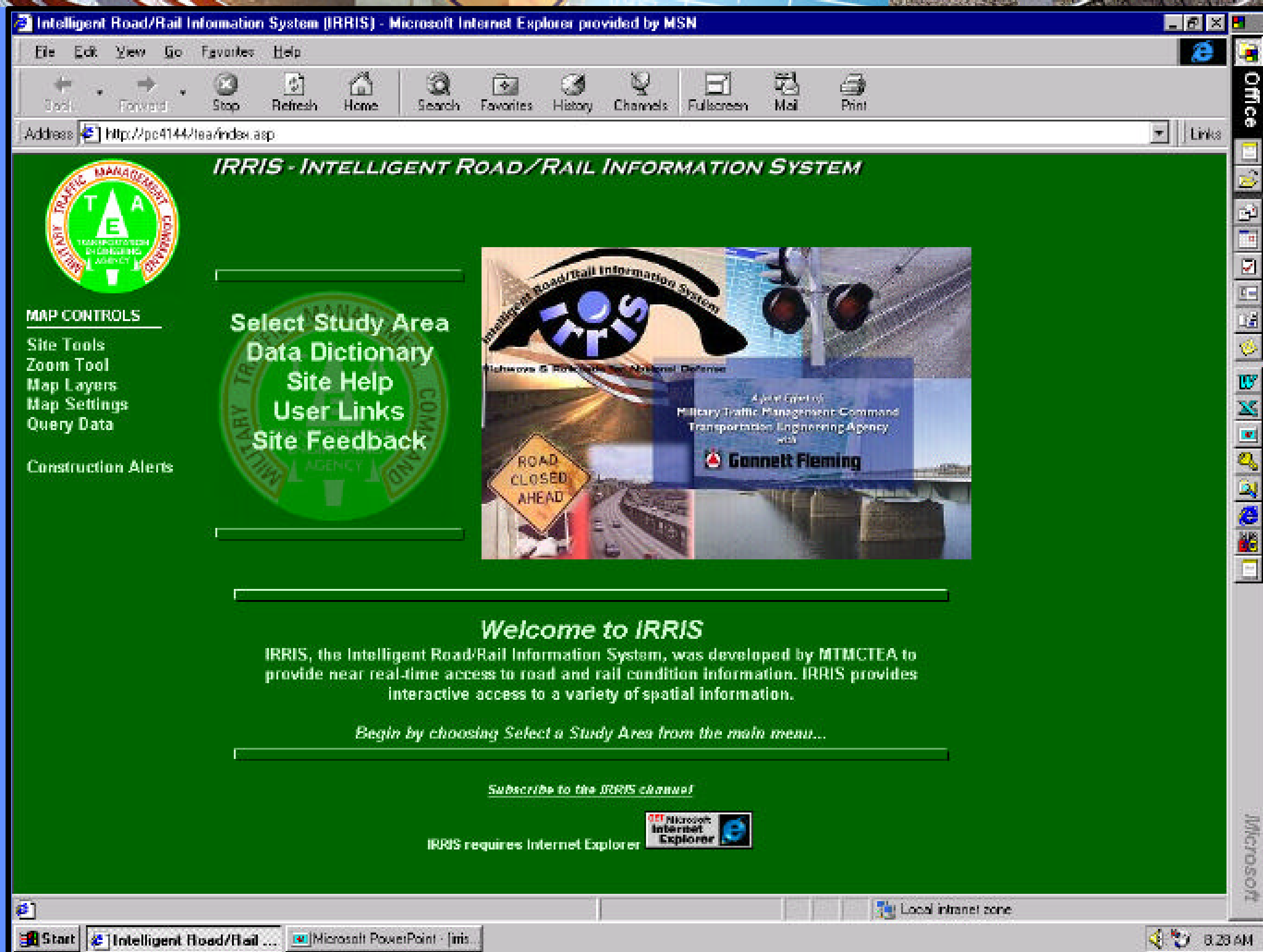


- Provide military deployment officials with route guidance based on real-time information
- Leverage Federal, state, and local Intelligent Transportation Systems for military use

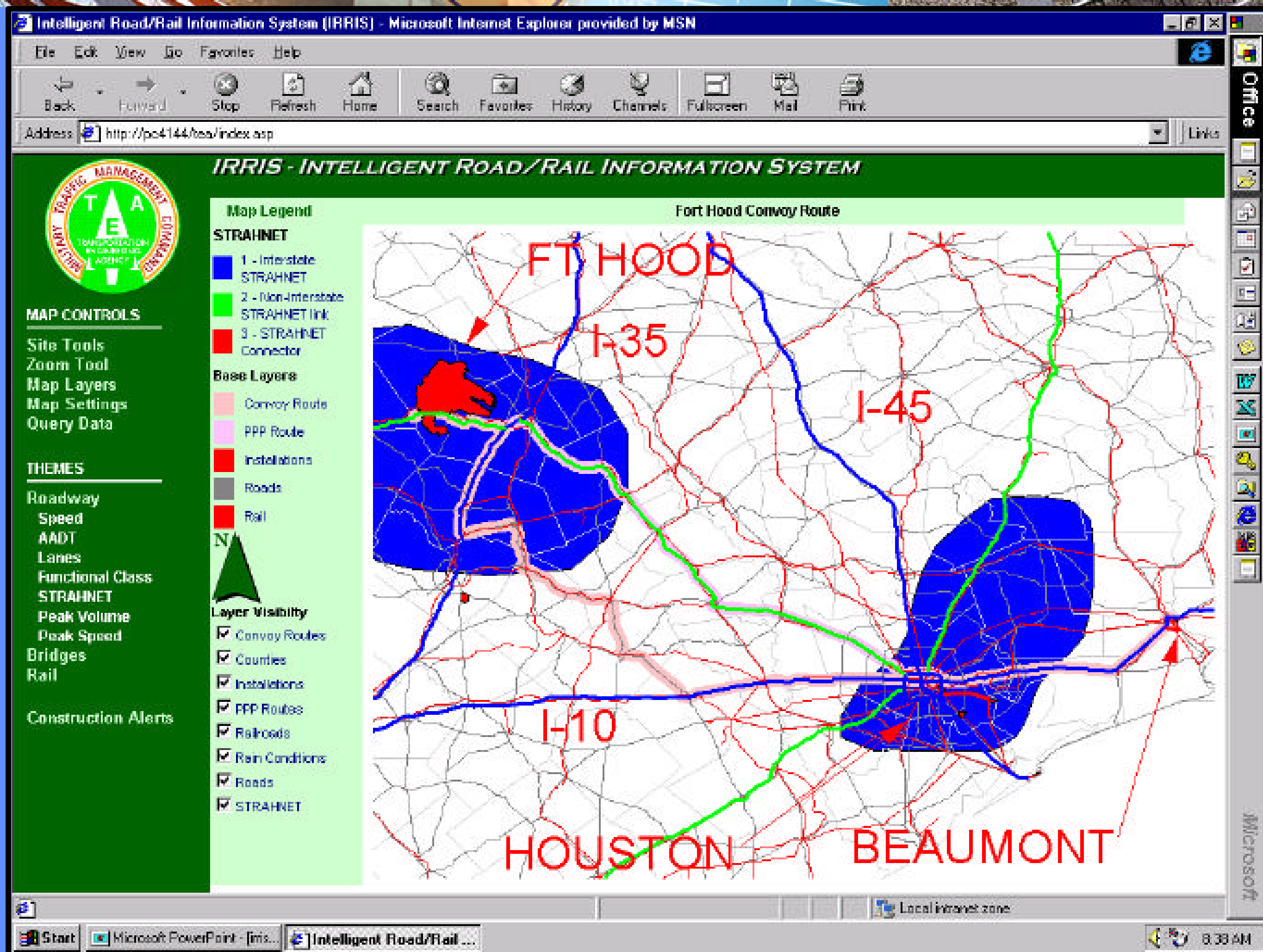
IRRIS Goals

- Provide Road/Rail Status Information for PPP Deployment Routes
  - Web based
  - Easy access
  - Add real time information
- Improve Force Closure for Deployment
- Expand Unit Deployment Training

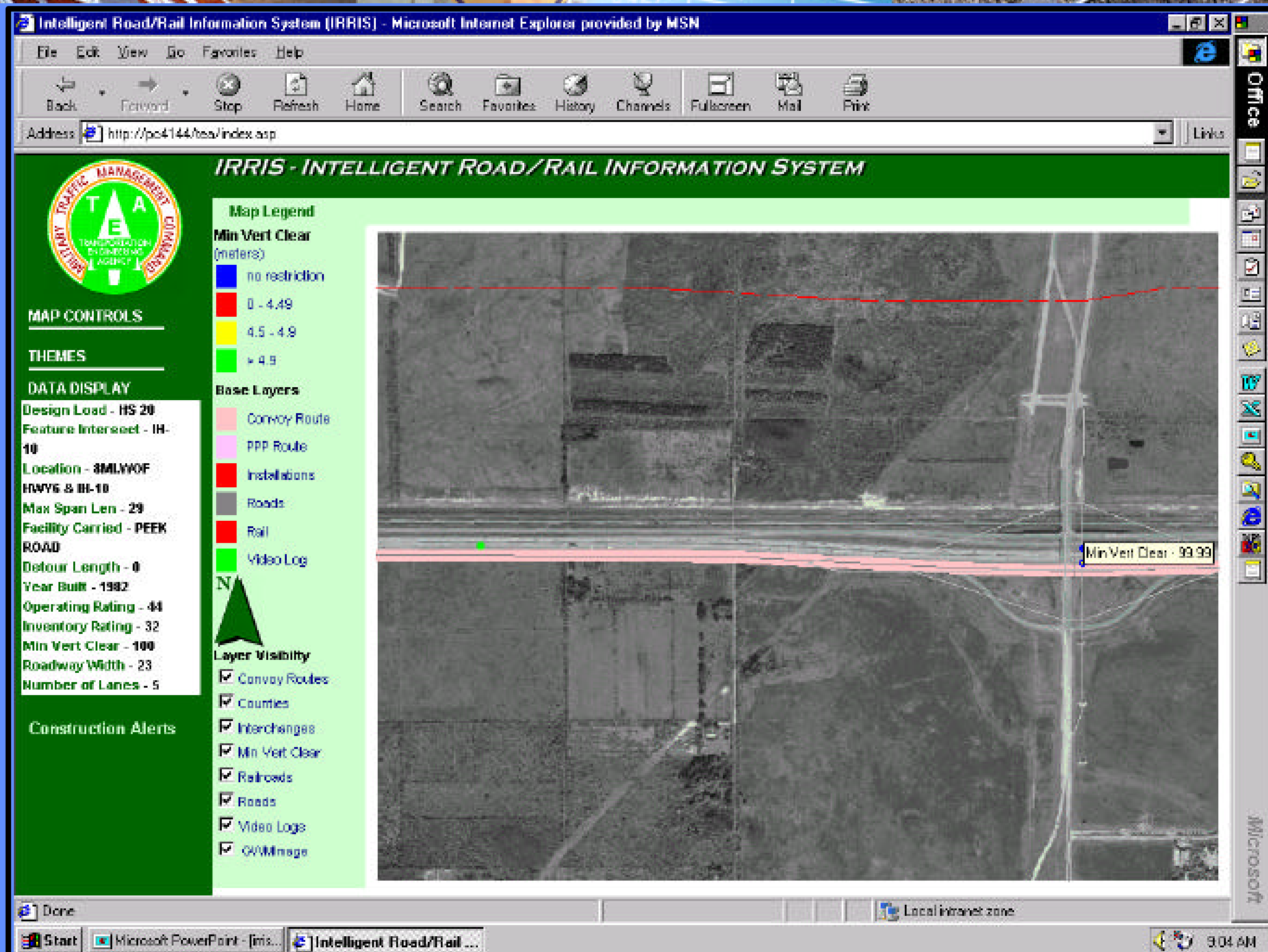
DEMONSTRATION Web Site:
http://207.140.67.27/default.htm



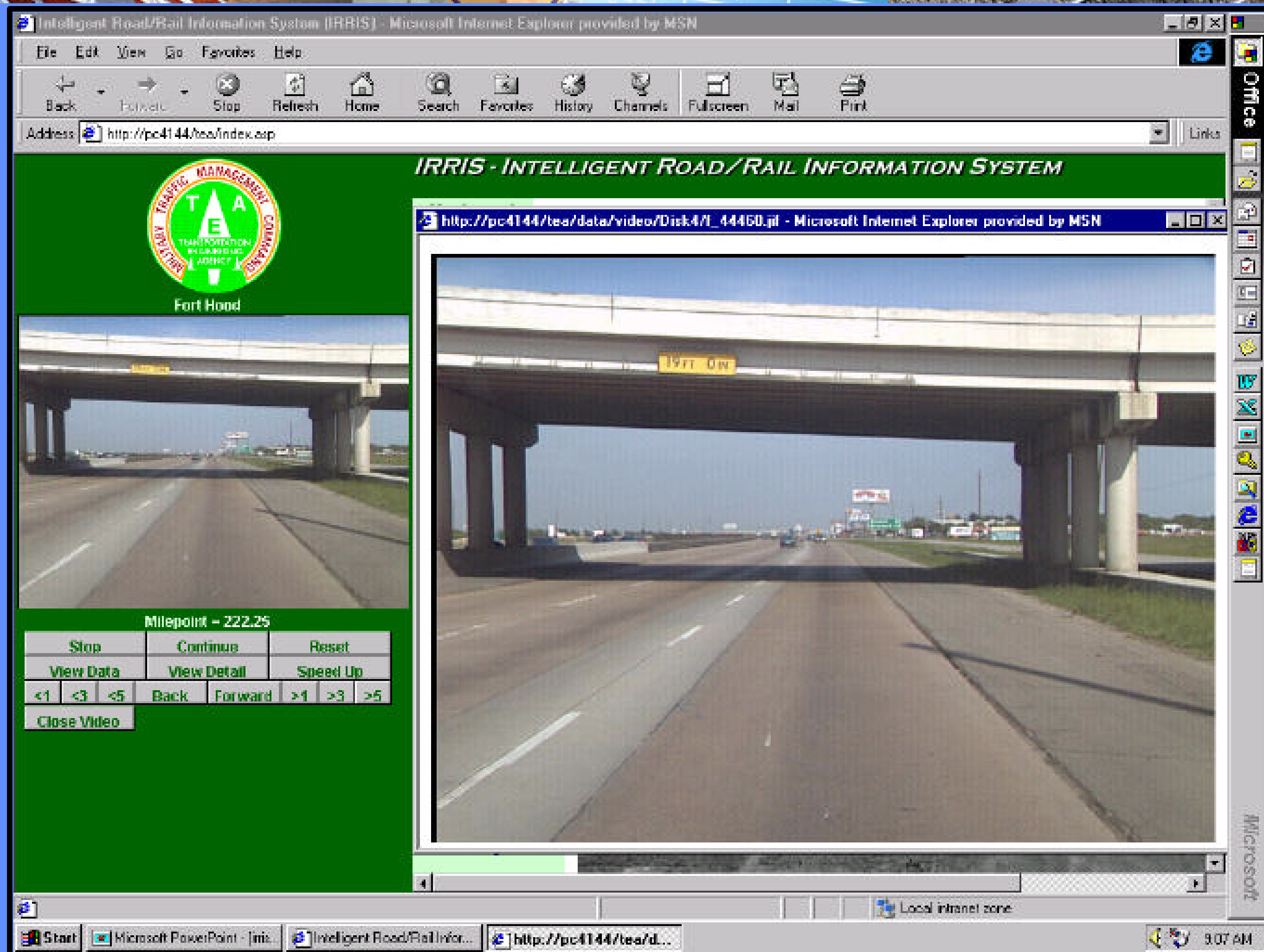
TEA - Turning Today's Visions into Tomorrows Strengths



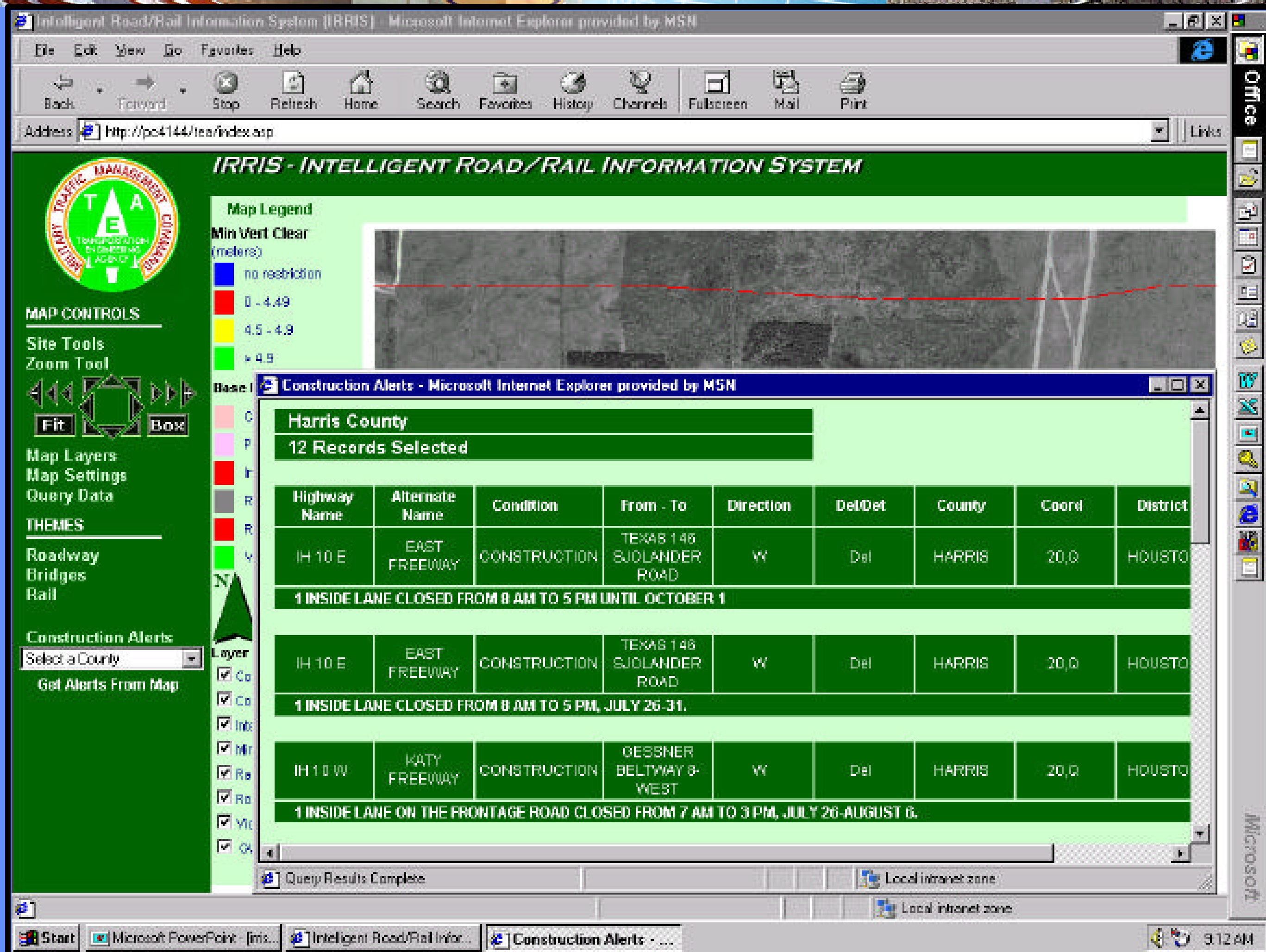
TEA - Turning Today's Visions into Tomorrows Strengths



TEA - Turning Today's Visions into Tomorrows Strengths



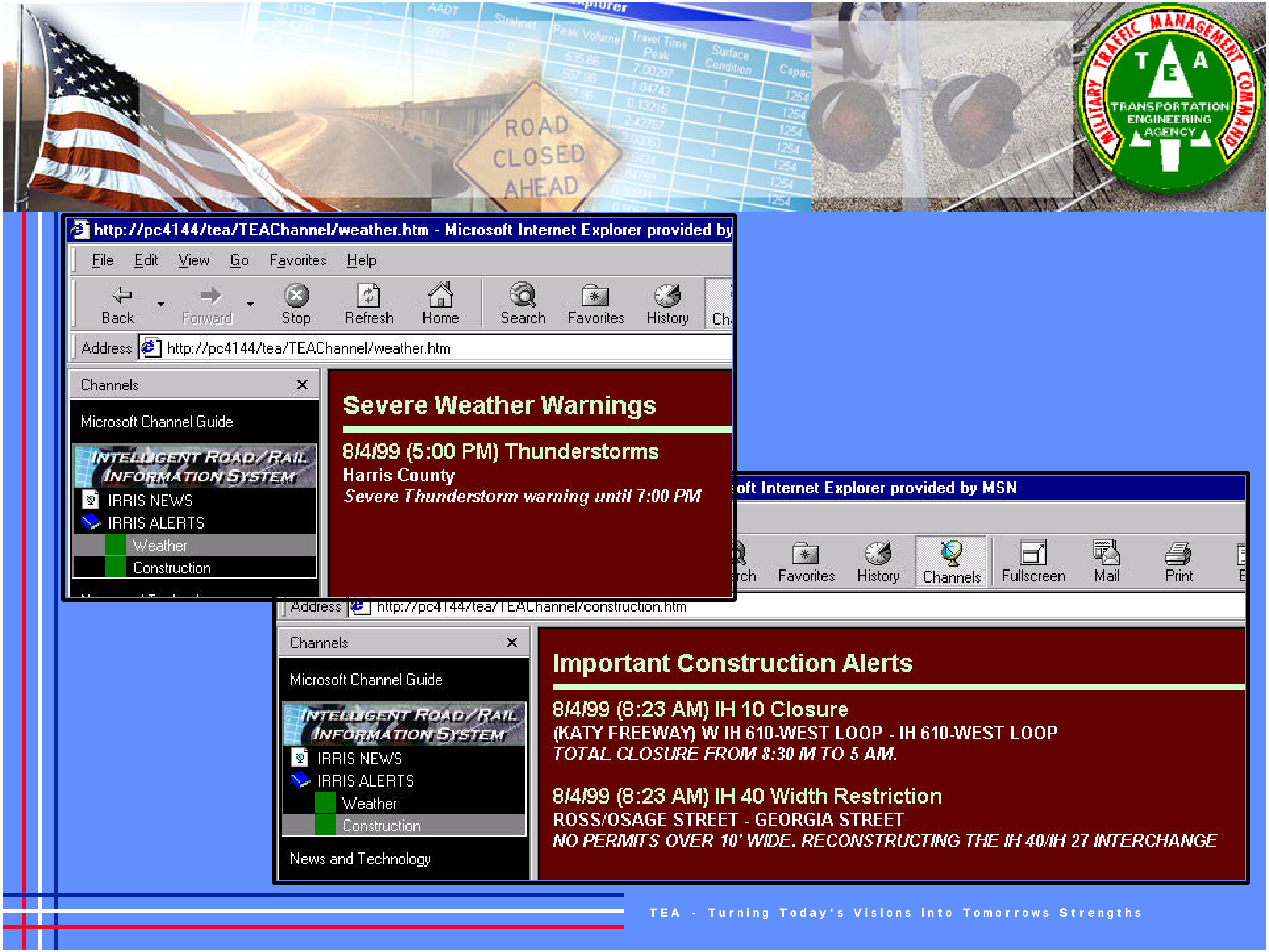
T E A - Turning Today's Visions into Tomorrows Strengths



TEA - Turning Today's Visions into Tomorrows Strengths

VDOT ITS - I-64 CAMERA

TEA - Turning Today's Visions into Tomorrows Strengths


ROAD CLOSED AHEAD
MILITARY TRAFFIC MANAGEMENT COMMAND
TEA
TRANSPORTATION ENGINEERING AGENCY
http://pc4144/tea/TEAChannel/weather.htm - Microsoft Internet Explorer provided by
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History
Address http://pc4144/tea/TEAChannel/weather.htm
Channels
Microsoft Channel Guide
INTELLIGENT ROAD/RAIL INFORMATION SYSTEM
IRRIS NEWS
IRRIS ALERTS
Weather
Construction
Severe Weather Warnings
8/4/99 (5:00 PM) Thunderstorms
Harris County
Severe Thunderstorm warning until 7:00 PM
oft Internet Explorer provided by MSN
Favorites History Channels Fullscreen Mail Print
Address http://pc4144/tea/TEAChannel/construction.htm
Channels
Microsoft Channel Guide
INTELLIGENT ROAD/RAIL INFORMATION SYSTEM
IRRIS NEWS
IRRIS ALERTS
Weather
Construction
News and Technology
Important Construction Alerts
8/4/99 (8:23 AM) IH 10 Closure
(KATY FREEWAY) W IH 610-WEST LOOP - IH 610-WEST LOOP
TOTAL CLOSURE FROM 8:30 M TO 5 AM.
8/4/99 (8:23 AM) IH 40 Width Restriction
ROSS/OSAGE STREET - GEORGIA STREET
NO PERMITS OVER 10' WIDE. RECONSTRUCTING THE IH 40/IH 27 INTERCHANGE
TEA - Turning Today's Visions into Tomorrows Strengths

- Paul Allred
- Phone: (757)599-1190
- FAX: (757)599-1682
- EMAIL: allredp@tea-emh1.army.mil
- Military Traffic Management Command
  Transportation Engineering Agency

I-99 Advanced Transportation Technology Test Bed

Paul P. Jovanis Ph.D.

Professor and Department Head

Civil and Environmental Engineering

Penn State University

Symposium on Weather Information for Surface Transportation

Silver Spring, MD   Nov 30-Dec 2, 1999

Overview

- I-99 Test Bed Concept
- Signing and Illumination Testing Facility
- Winter Maintenance and Hazardous Materials Routing
- Ground and Surface Water Issues
- Summary

I-99 Test Bed Concept

- Highway Proximate to Penn State
- Develop *In Situ* Laboratory for Testing Advanced Technologies
- Tie Infrastructure Monitoring to Management Center
- Comprehensive Program:
  - Bridges - Traffic
  - Pavements - Environment

Signing and Illumination Facility

- Facilitate Testing of Advanced Signing Materials and Illumination Systems
- “Smart” Lighting that Responds to Ambient Conditions
- Enhance Mobility and Safety During Adverse Weather
- Significant Private Sector Interest
- Leader: Dr. Martin Pietrucha

Routing and Scheduling for Winter Maintenance

- Predicted Road Conditions
- Weather Forecast
- Complex Optimization Problem
  - Fixed Vehicle Capacity
  - Vehicle Positioning
  - Real-time Routing
- Leader: Dr. Elise Miller-Hooks

Hazardous Materials Routing

- Minimize Accident Risk and Environmental Impact
- Estimate Risk in Real-time and Generate Route
  - Road Geometry
  - Weather
  - Historical Crash Data
- Leader: Dr. Elise Miller-Hooks

Environmental Issues

- Long-term Ground Water Monitoring
- Proposed Modeling to Shorten Monitoring Mandate
- Stream Restoration, Mitigation
- Leaders: Dr. Art Miller, Dr. Peggy Johnson

Summary

- Enhanced Infrastructure Management Through Technology
- Extensive Roadway Sensors Planned
- Assess Atmospheric Instrumentation Needed for Advanced Weather Prediction in Rural Transportation Applications
- Seeking Partners

usa
DIGITAL
RADIO

The Digital AM & FM Experience

AM and FM Digital Audio Broadcasting for the United States

usa DIGITAL RADIO

CBS

COX RADIO, INC.

RADIO ONE
THE URBAN RADIO SPECIALIST

am·fm
AMERICA'S MEDIUM FOR THE MILLENNIUM

CLEAR CHANNEL COMMUNICATIONS, INC.

ENTERCOM

CUMULUS

emmis communications

SBG
SINCLAIR BROADCAST GROUP, INC.

GANNETT

abc ABC RADIO NETWORKS

HBC
HISPANIC BROADCASTING CORPORATION

Citadel Communications Corporation

CHASE

usa DIGITAL RADIO

Broadcast Owner Infrastructure

- Owned by 12 of the Nation's Largest Broadcasters (Including the top 10)
- Presence in 196 of 270 Arbitron markets through 1785 stations, access to 200 Million listeners (reaching 101 Million)
- In Top 50 markets alone, 704 Owner stations have 12+ share of 56% reaching 82 Million listeners
- Owners account for 46% of radio industry revenue (70% in the top 50 markets)

Forming Coalition To Drive DAB Forward

Broadcasters

Transmission Equipment Mfg.'s

(Additional Agreements Expected)
Receiver Mfg.'s

Other Development Partners

(Studies Being Conducted)
Content Providers

(Discussions Underway)
Retailers/ Auto Mfgs

(Additional Agreements Expected)
Chip Mfg.'s

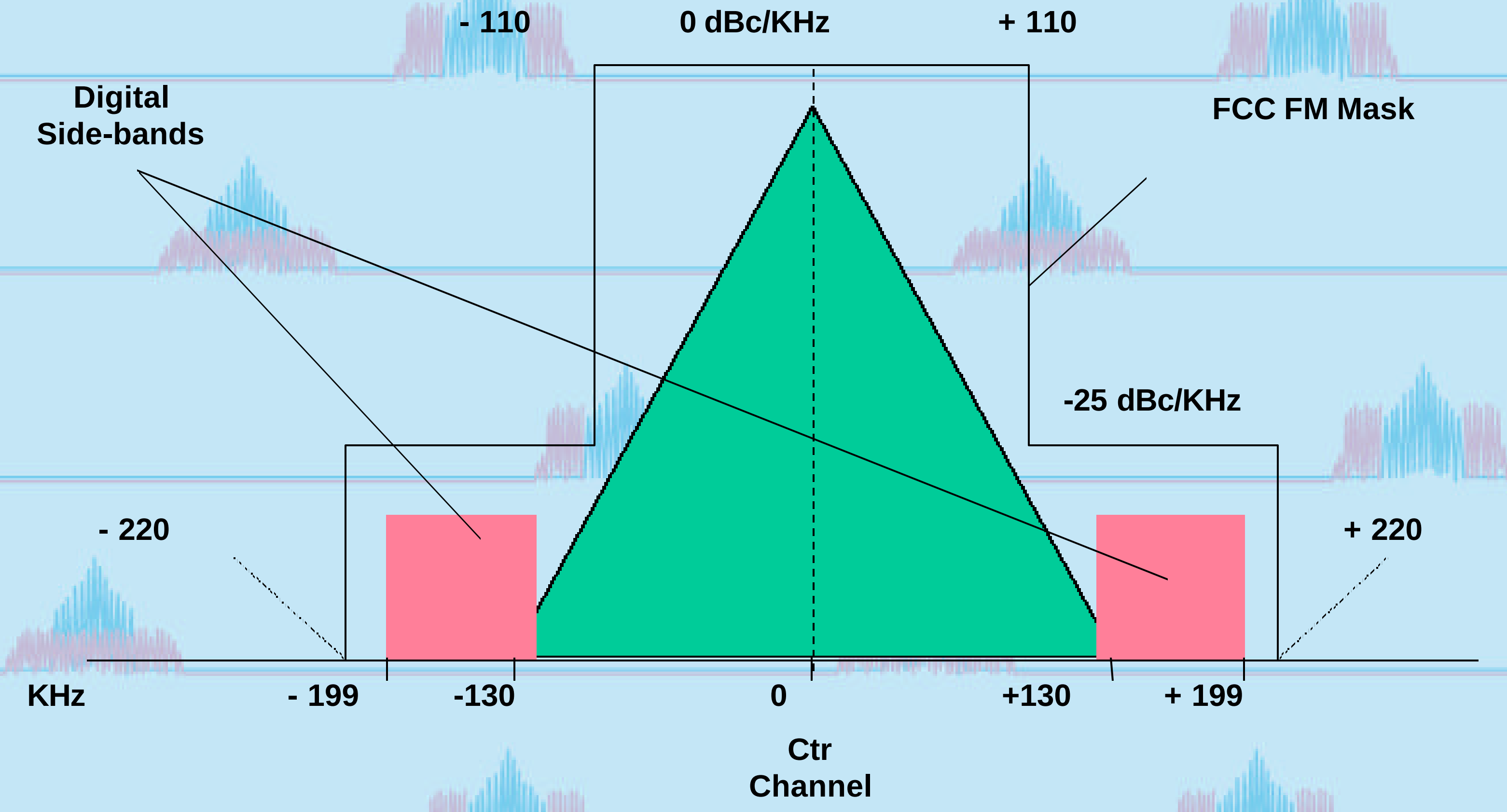
What is IBOC DAB?

Digital Audio Broadcasting (DAB) is a Digital Method of Transmitting Near-CD Quality Audio Signals and Data Services to Radio Receivers

In-Band On-Channel (IBOC) DAB is the strategic placement of digital audio and data signals in the AM and FM bands (IN BAND) at current radio station dial positions (ON CHANNEL)

Hybrid FM IBOC Mode

(Simultaneous Transmission of Analog and Digital)



POWER
MENU
Stereo
72° F
Thurs Nov 18 10:36 AM
93.5 FM WTST
The digital music alternative
Now Playing
"Voyager One"
by Outer Body Llama
from Electric Child Freakshow
OUTER BODY LLAMA
Severe thunderstorm issued for Suffolk county
VOL
1 ABCD
2 EFGH
3 IJKL
4 MNOP
5 QRST
6 UVWX
7 YZ*#

A Robust, Mobile Data Pipe Creates New Services And Applications Opportunities

Datacasting

- **Program Associated Data: Song, Artist, Title, Station Call Letters**
- **Paging-like Services: Traffic, Weather, Scores, Quotes**
- **Emergency/Safety Announcements**

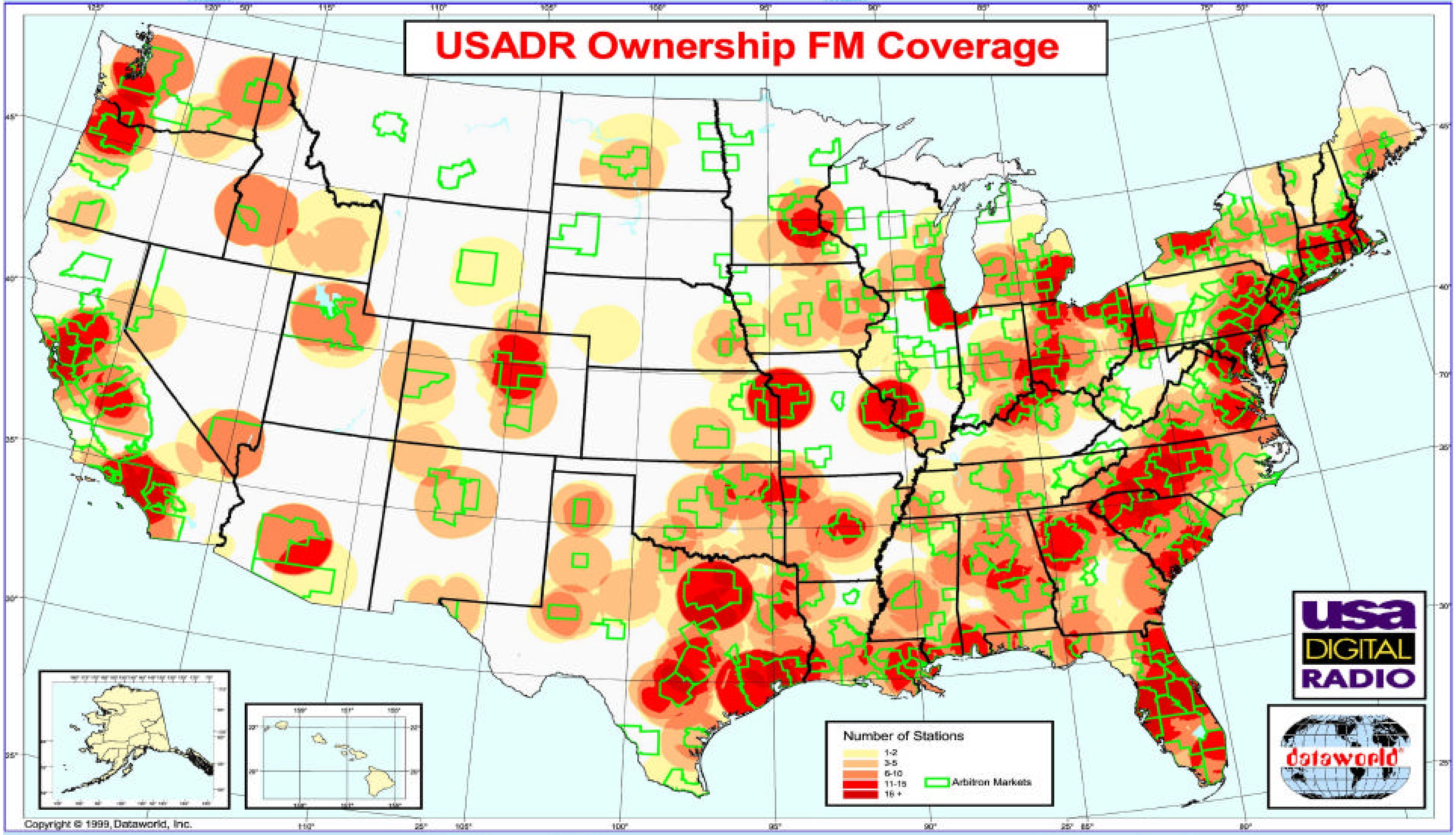
Digital Storage

- **Store and Replay, Custom Programs**
- **Downloadable Digital Content Recording**

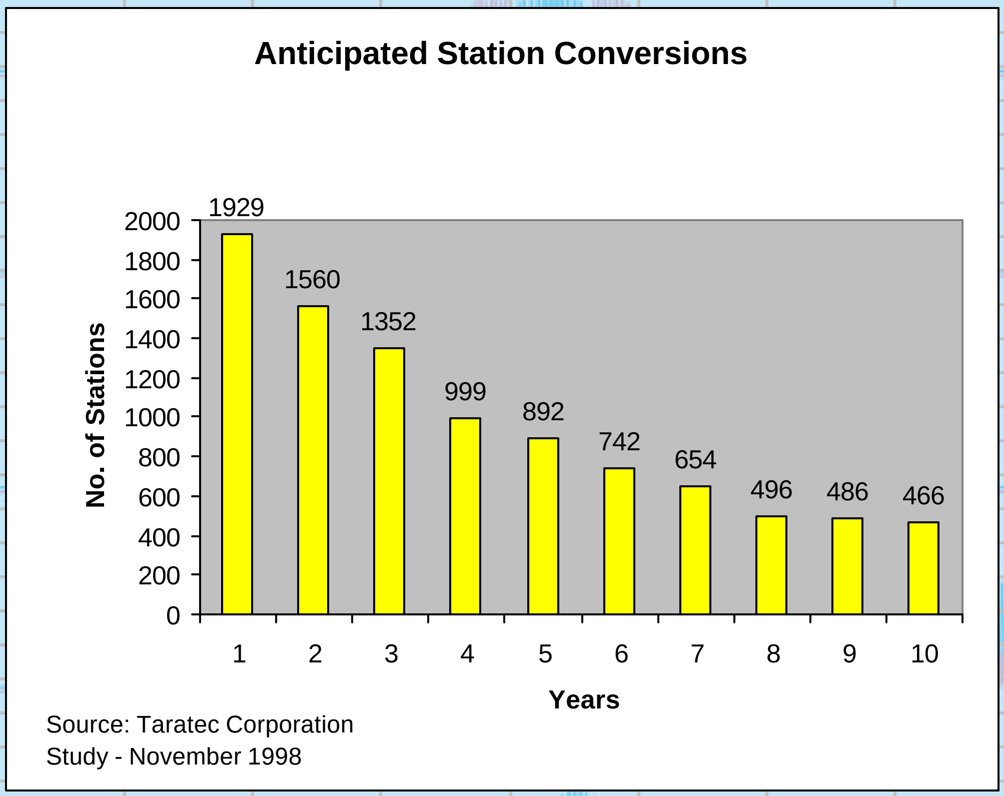
Interactive Services (through cell phone or other return channel)

- **Product Ordering Services**
- **Navigation and Concierge Services**
- **Entertainment, E-Mail, Internet, etc.**

Owner's stations cover major population centers



High Broadcaster Acceptance Anticipated



- 30% of Stations Anticipated to Convert in First Two Years
- 56% of Stations Anticipated to Convert in First Five Years
- AM/FM DAB's Average Rank of Importance is 4.14 on Scale of 1 to 5

Source: Independent research firm study - November 1998

IBOC DAB Timetable

- Complete Testing of Technology and Continued Coalition Building in 1999 and Early 2000
- Regulatory Approval and Broadcaster Rollout Expected by Mid 2000
- First Transmission Equipment Expected to Enter Markets in Late 2000/Early 2001
- First Receivers Expected to Enter Markets in 2001
- Anticipated Focus of First Generation Products on Aftermarket Auto and Hi-End Home Stereos with OEM and Portable to Follow

Applications for the Intelligent Transportation System

Presented by: Michael D. Eilts

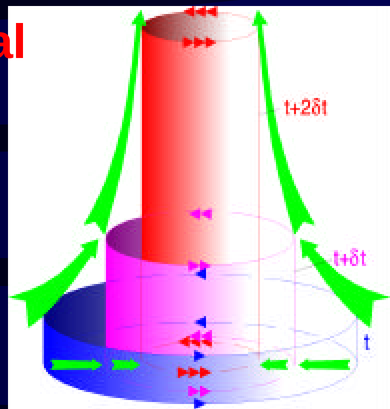
Assistant Director

Dec 2, 1999

The NSSL Mission:

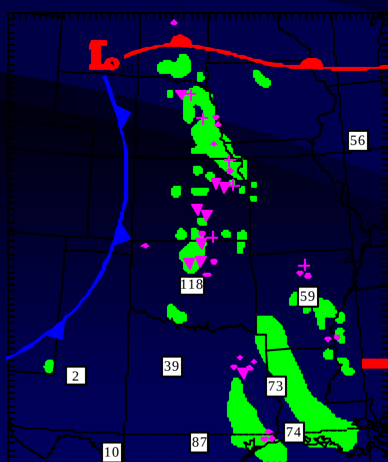
To work in partnership with the National Weather Service to enhance NOAA's and our other customers capability of providing accurate forecasts and warnings of all types of hazardous weather.

Theoretical Studies



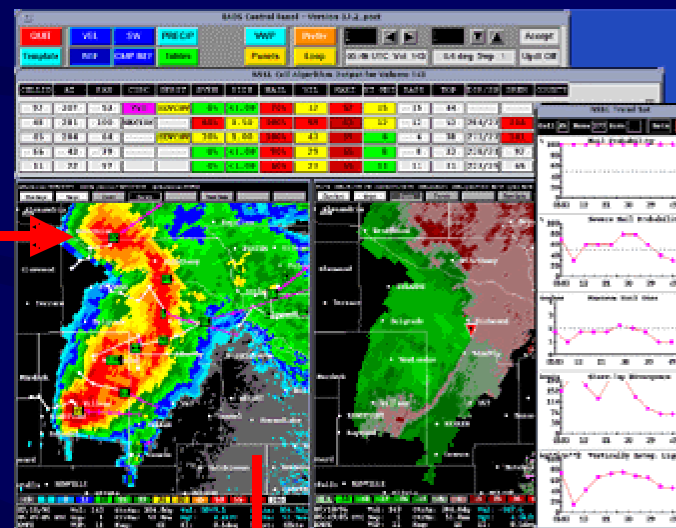
Observational Studies

Modeling Studies



Understand Severe Weather Processes

Applications and Systems



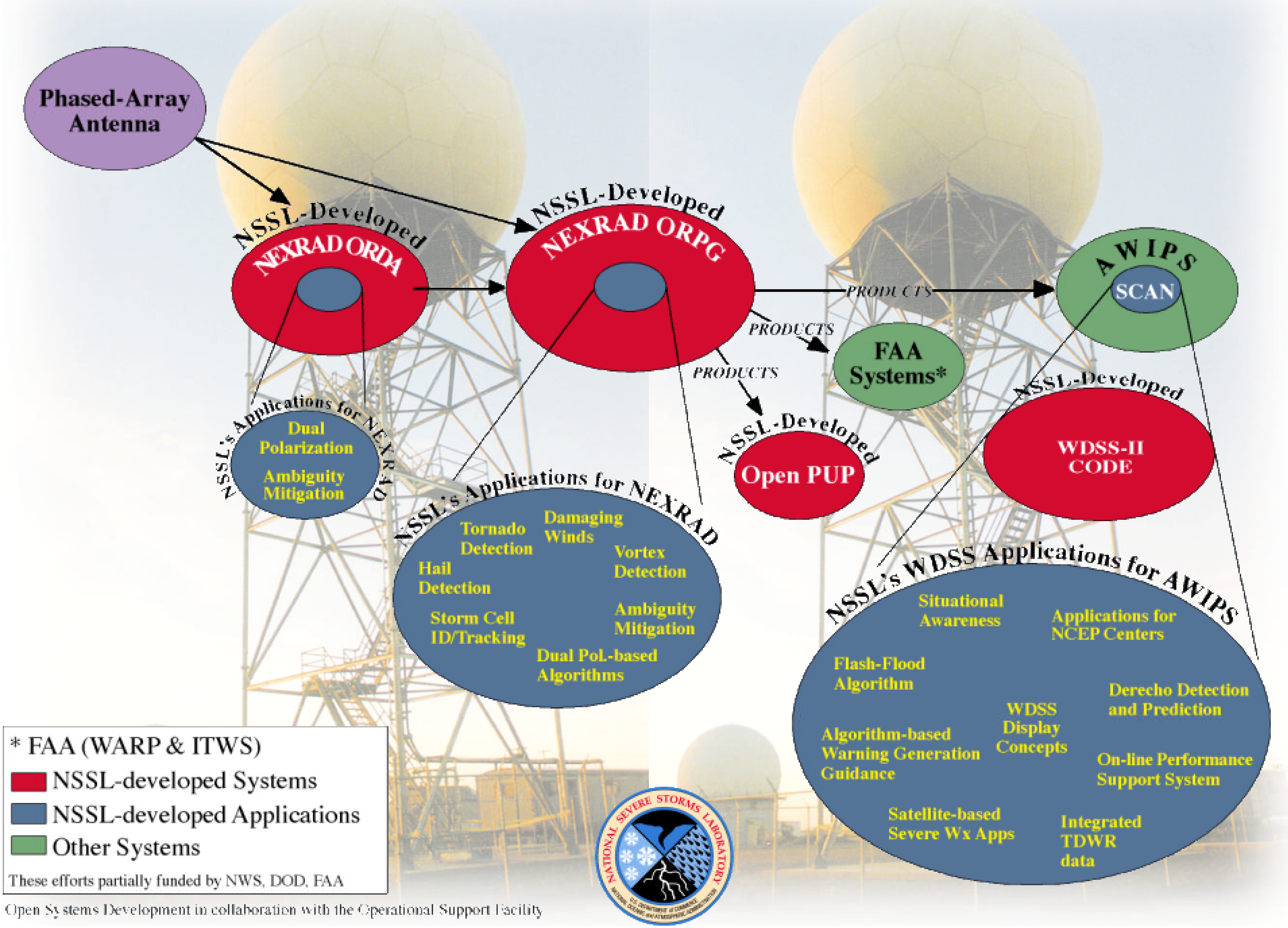
NOAA Services

NEXRAD Program

+ Our other Customers:

- Electric Utilities
- Aviation
- NASA
- DOD
- Foreign Governments

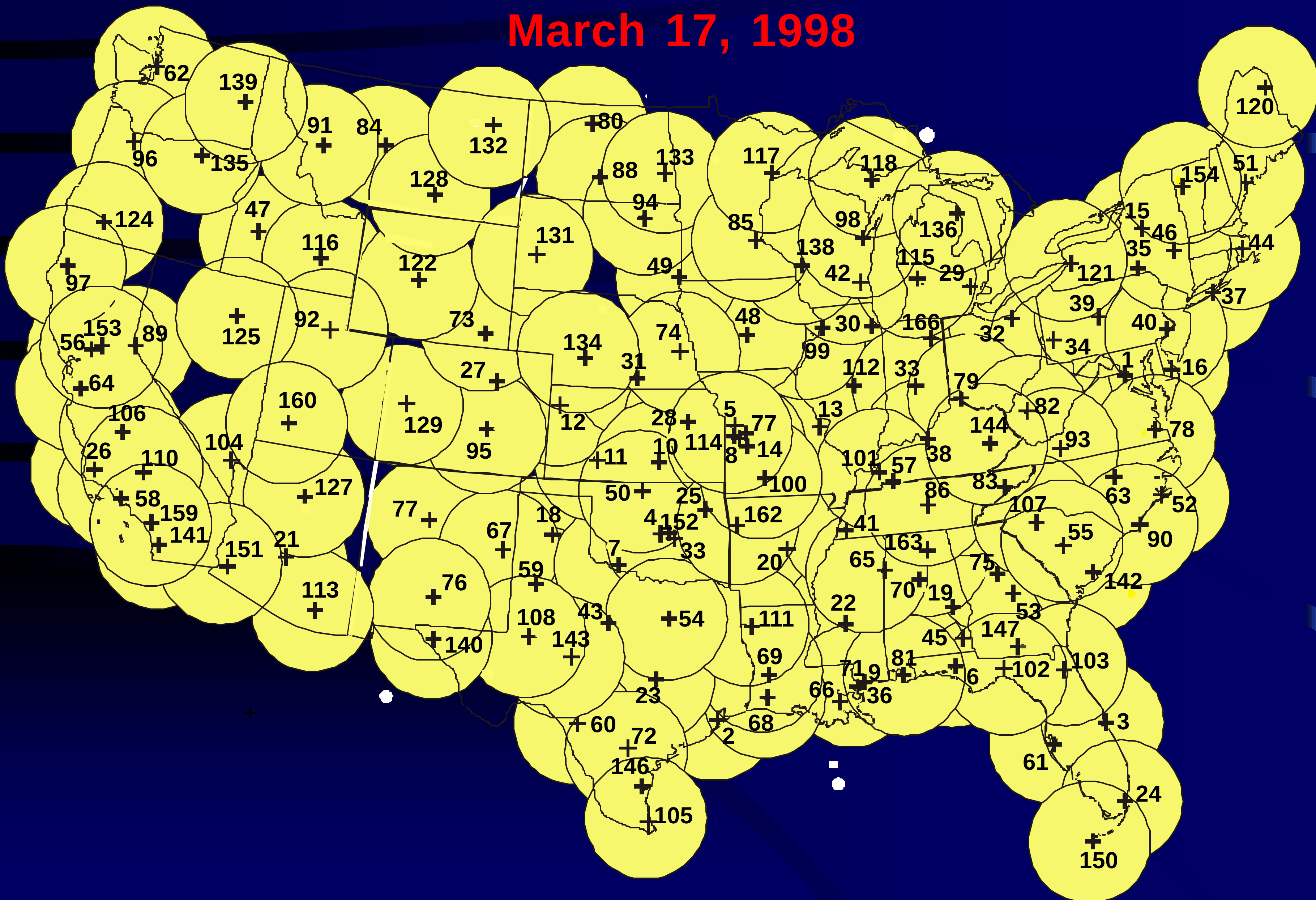
Vision of Some of NSSL's Contributions to Weather Systems



Open Systems Development in collaboration with the Operational Support Facility

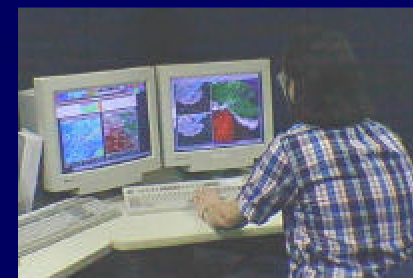
COMPLETED WSR-88D INSTALLATIONS WITHIN THE CONTIGUOUS U.S.

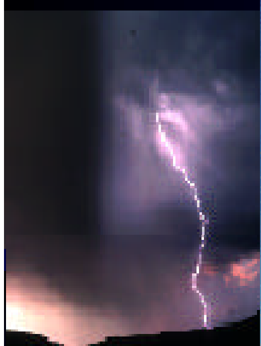
March 17, 1998



Warning Decision Support System

• **Goal is to put the right information in the hands of the forecaster in a timely fashion to help them make more effective, efficient and timely warning decisions. WDSS's role is a prototype for algorithms and display concepts for the WSR-88D and AWIPS/SCAN.**

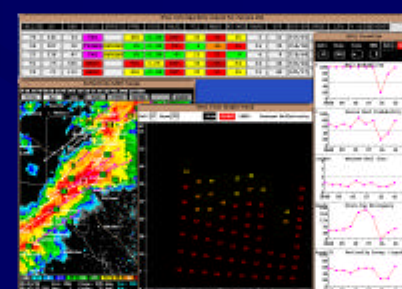




•**Uses data from WSR-88D, NLDN and RUC - II.**

• **Utilizes image processing, expert systems, artificial intelligence and statistical techniques to turn data into useful information.**

• **Interactive display allows the forecaster or other user easy access to information and directs them to the most critical weather phenomena; concept is "selective disclosure".**

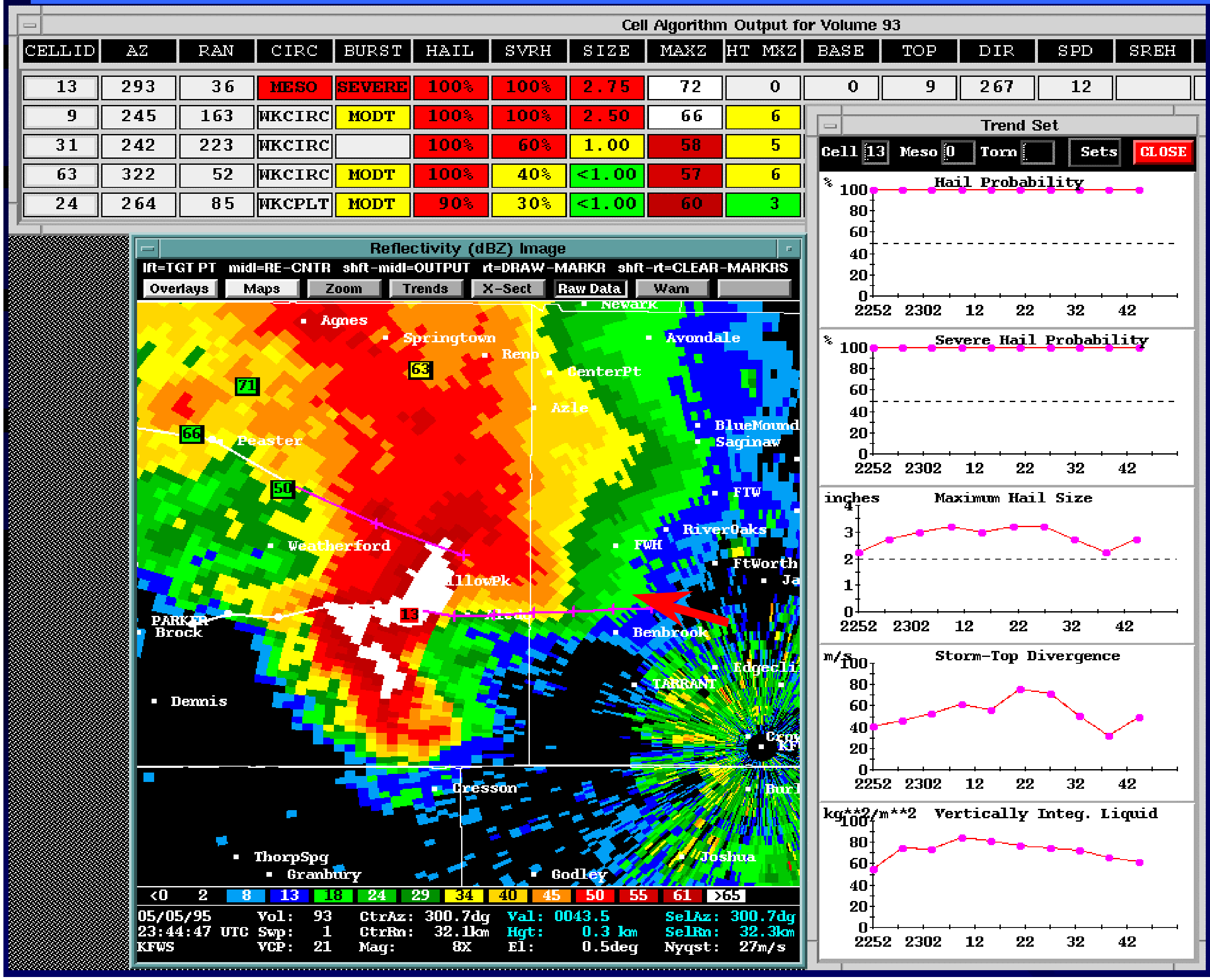


Warning Decision Support System Components

- **Detection, Diagnosis, and Prediction Algorithms:**
  - Storm Cell Identification and Tracking
  - Hail Detection
  - Mesocyclone Detection
  - Tornado Detection
  - Damaging Downburst Prediction and Detection
  - Flash Flood Prediction
  - Precipitation Accumulation
  - Lightning Association and Threat Area
  - Forecast of 30 minute and 1 hour reflectivity fields
  - Snowfall Accumulation
  - Dual-Polarization Algorithms (better QPE and precip type)

- **Near-Storm Environment (NSE) Analysis - data integration to understand the thermodynamics and kinematics of the near-storm environment.**
- **Interactive Display designed specifically for rapid access to the most important information**

Hail Detection and Storm Cell Identification and Tracking Algorithms



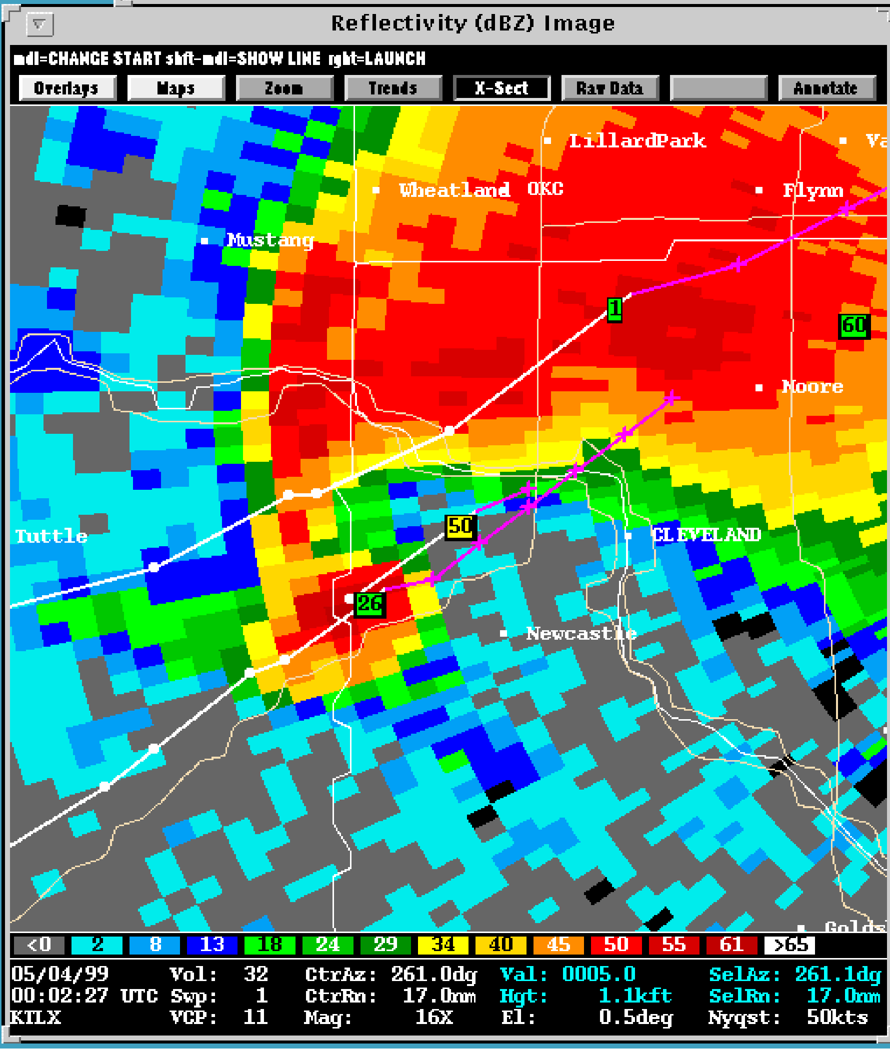
May 5, 1995

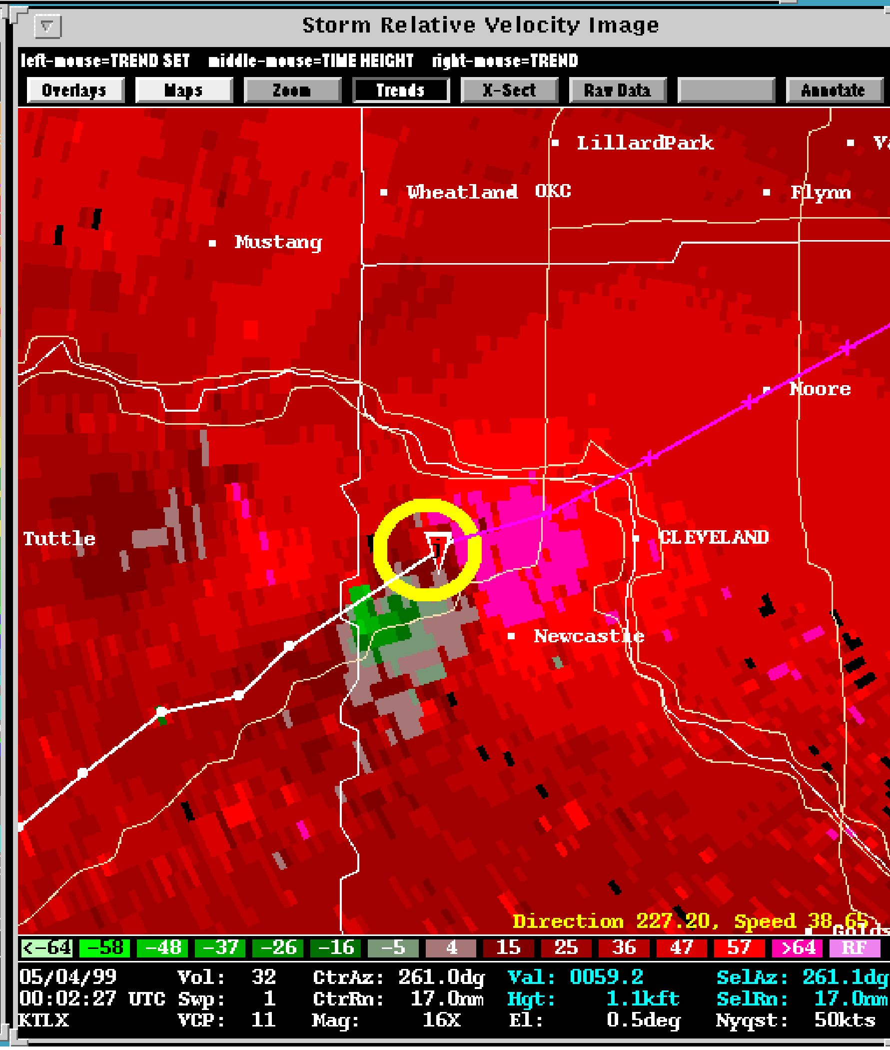
HDA detecting large hail event that caused significant damage (3.5 inch hail seriously injuring 109 people) during an outdoor Mayfest celebration. This storm continued across the DFW Metroplex, killing 18 people in flash floods and doing $1.2 billion damage mostly from hail.

Mesocyclone and Tornado Detection Algorithms

NSSL Cell Algorithm Output for Volume 32

CELLID	AZ	RAN	CIRC	BURST	SVRH	SIZE	HAIL	VIL	MAXZ	HT MXZ	BASE	TOP	DIR/SP	SREH
50	261	17	TVSMES	SEVCNV	40%	2.25	90%	28	57	22	16	28	227/17	358
51	307	44	TVSMES		20%	1.75	100%	24	53	16	8	37	236/27	381
36	258	50	MESO	SEVCNV	30%	2.00	100%	40	55	4	4	47	244/25	391
37	314	72	CIRC		40%	2.00	100%	39	55	15	7	36	207/45	121
45	329	103	CIRC		60%	1.25	100%	56	57	24	13	34	164/23	240





Flash FloodApplication Development/Testing

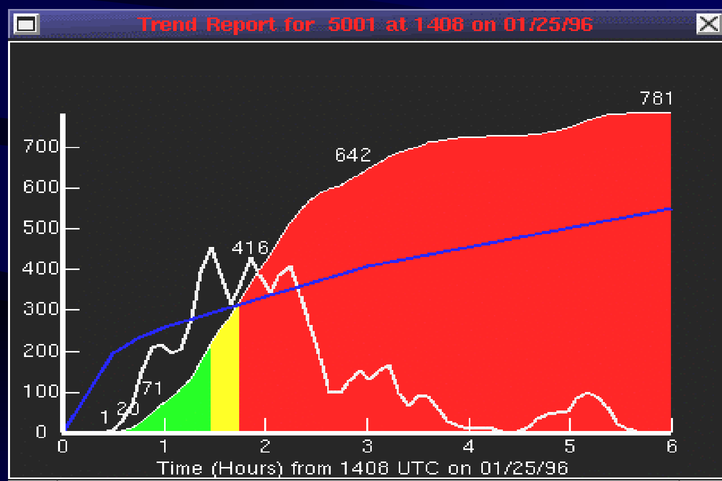
Objectives

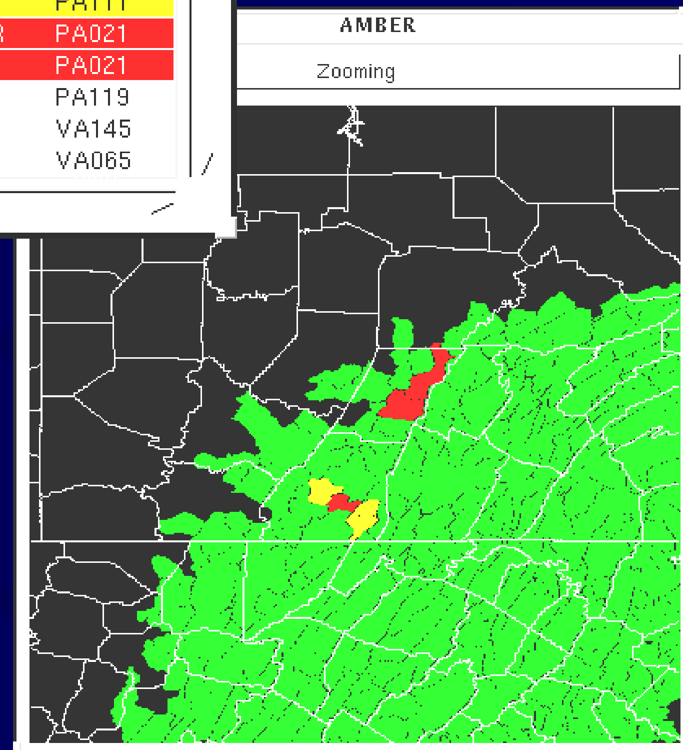
- Use integrated data sources such as radar and satellite to provide early flash flood warnings
- Use latest GIS advances to provide the best possible hydro-logical basin resolution

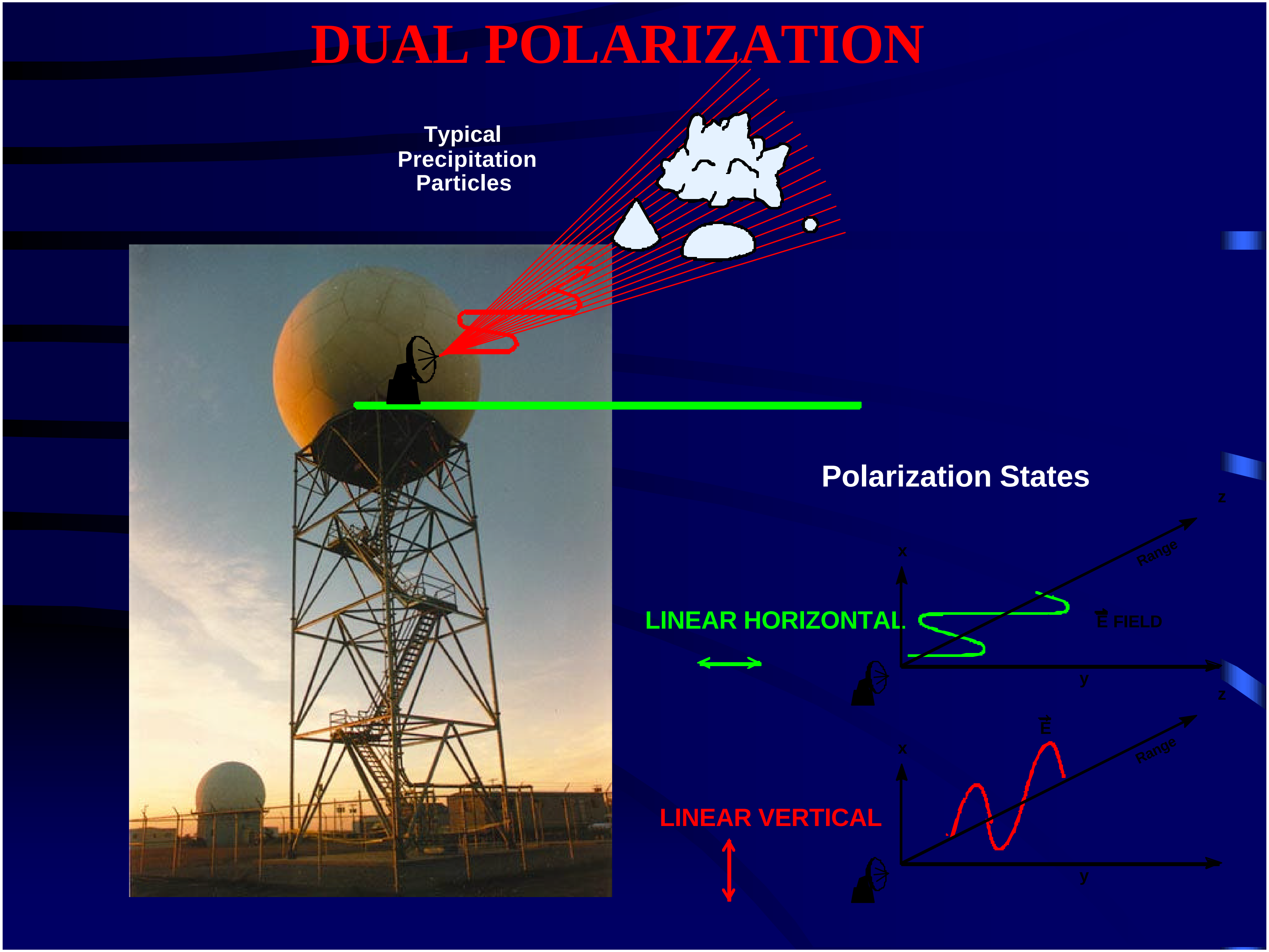
Flash Flood Prediction

Table

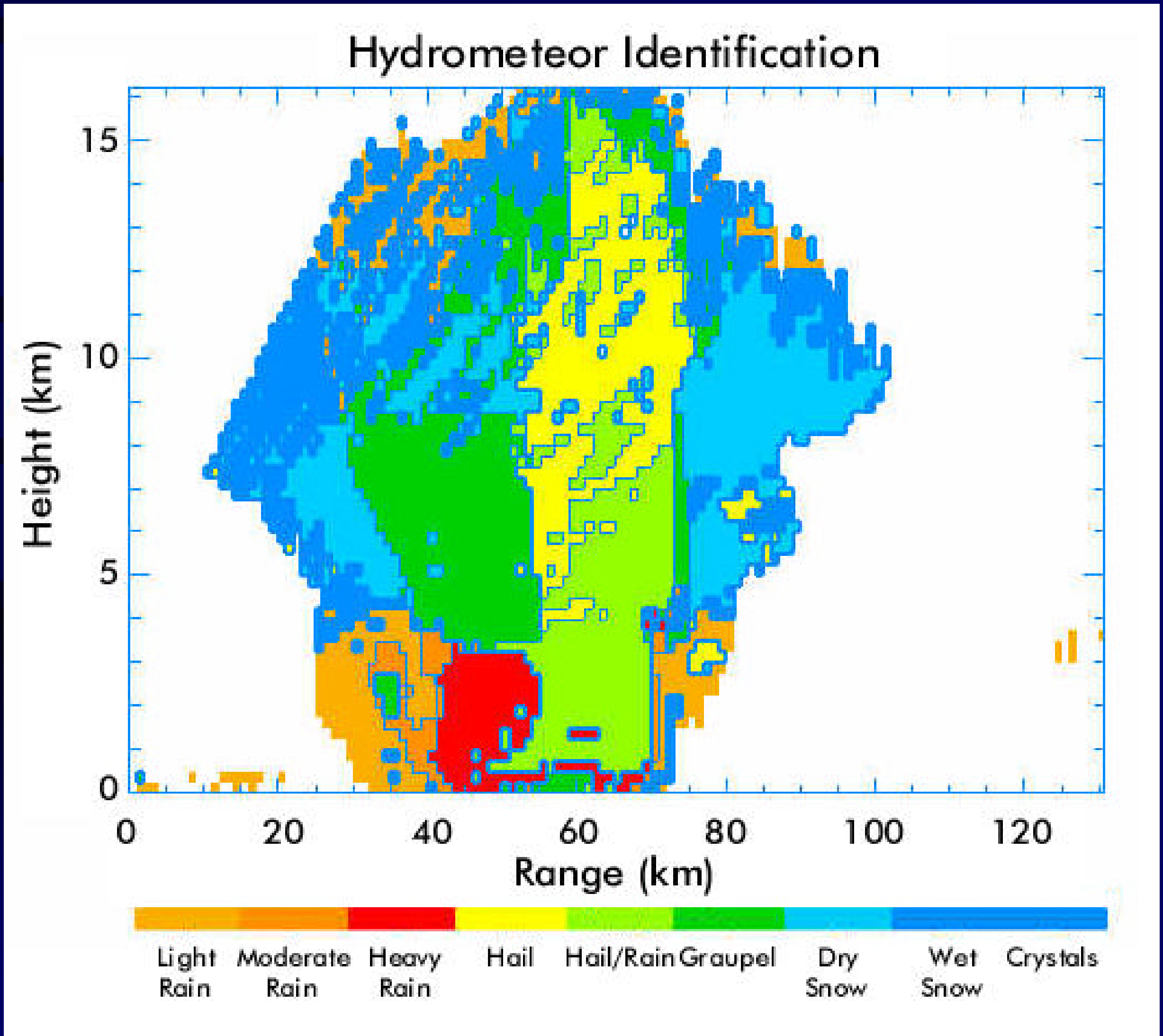
Basin #	0.5 Hr	0.75 Hr	1 Hr	2 Hr	3 Hr	6 Hr	Basin Name	FIPS	L
1092	66	68	71	57	47	101	Buffalo Creek	PA111	
1098	68	64	62	48	39	85	Brush Creek	PA111	
1086	40	50	58	51	42	94	Coxes Creek	PA111	
1104	47	51	53	44	37	90	Laurel Run&Mtn Run of Wills Cr	PA111	
1047	26	41	53	44	35	105	N Branch of Little Conemaugh R	PA021	
1014	35	47	50	39	31	104	Clearfield Creek	PA021	
1440	0	0	0	0	0	0	Penns Creek	PA119	
1439	0	0	0	0	0	0	James R-Richmond	VA145	
1438	0	0	0	0	0	0	James R-Cartersville	VA065	






DUAL POLARIZATION
Typical Precipitation Particles
Polarization States
LINEAR HORIZONTAL
x
y
z
Range
E FIELD
LINEAR VERTICAL
x
y
z
Range
E

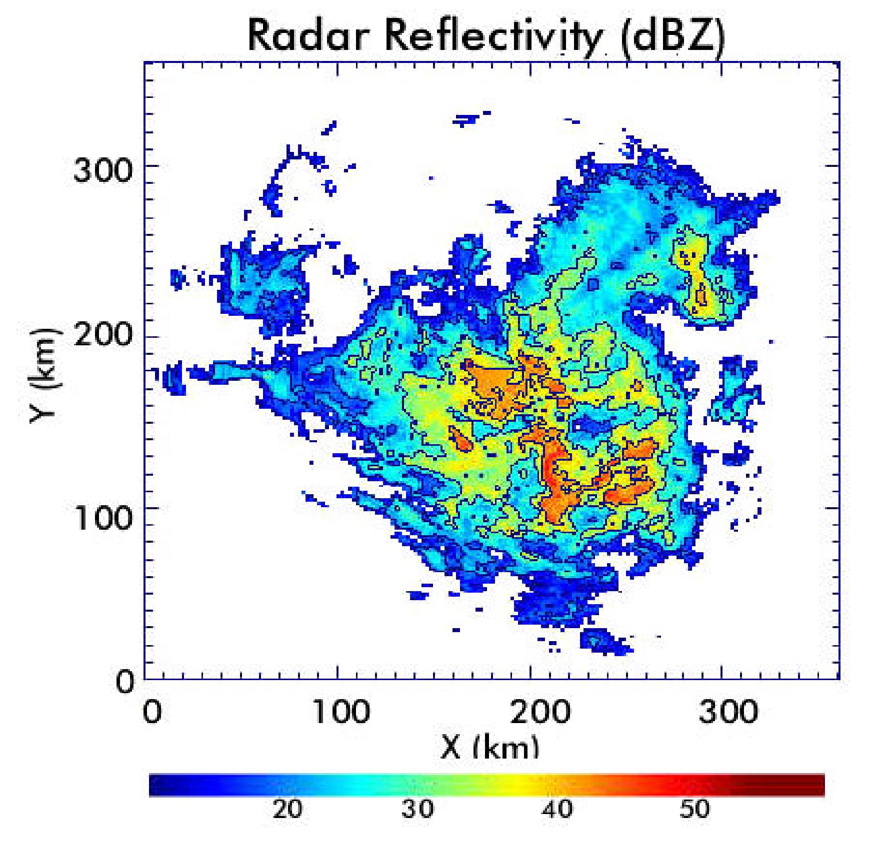
Classification of Hydrometeors in a Hailstorm Using A Fuzzy Logic Algorithm

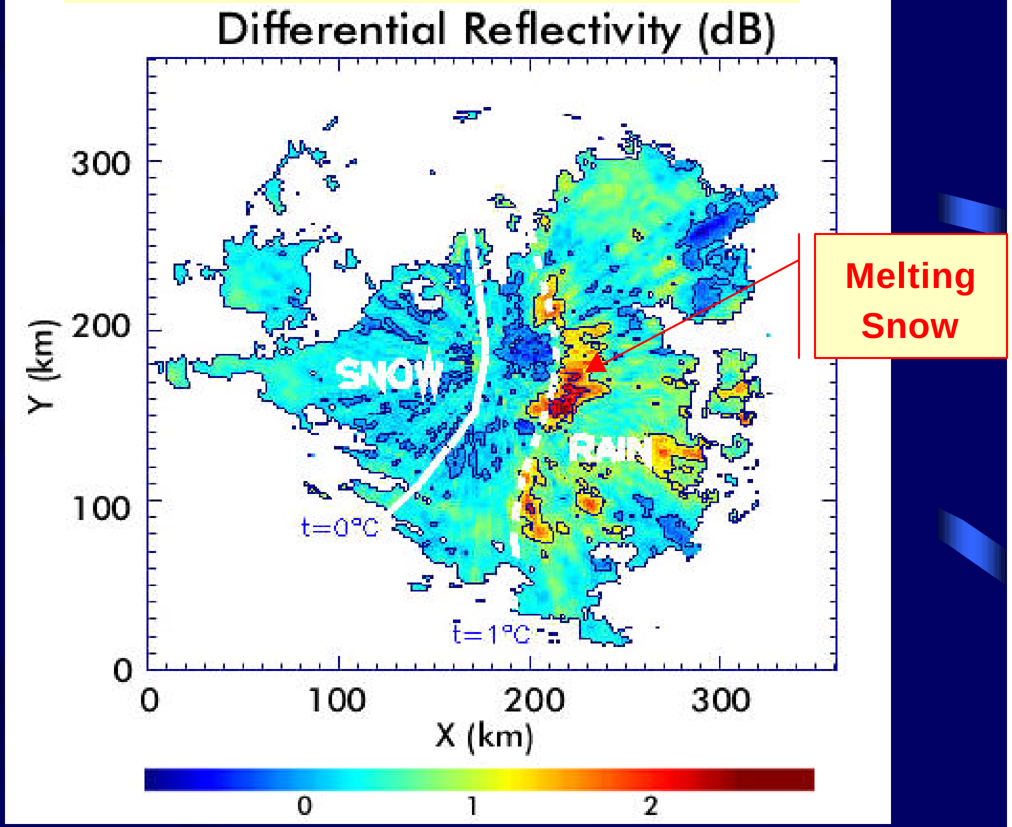


Discrimination Between Snow, Melting Snow, and Rain

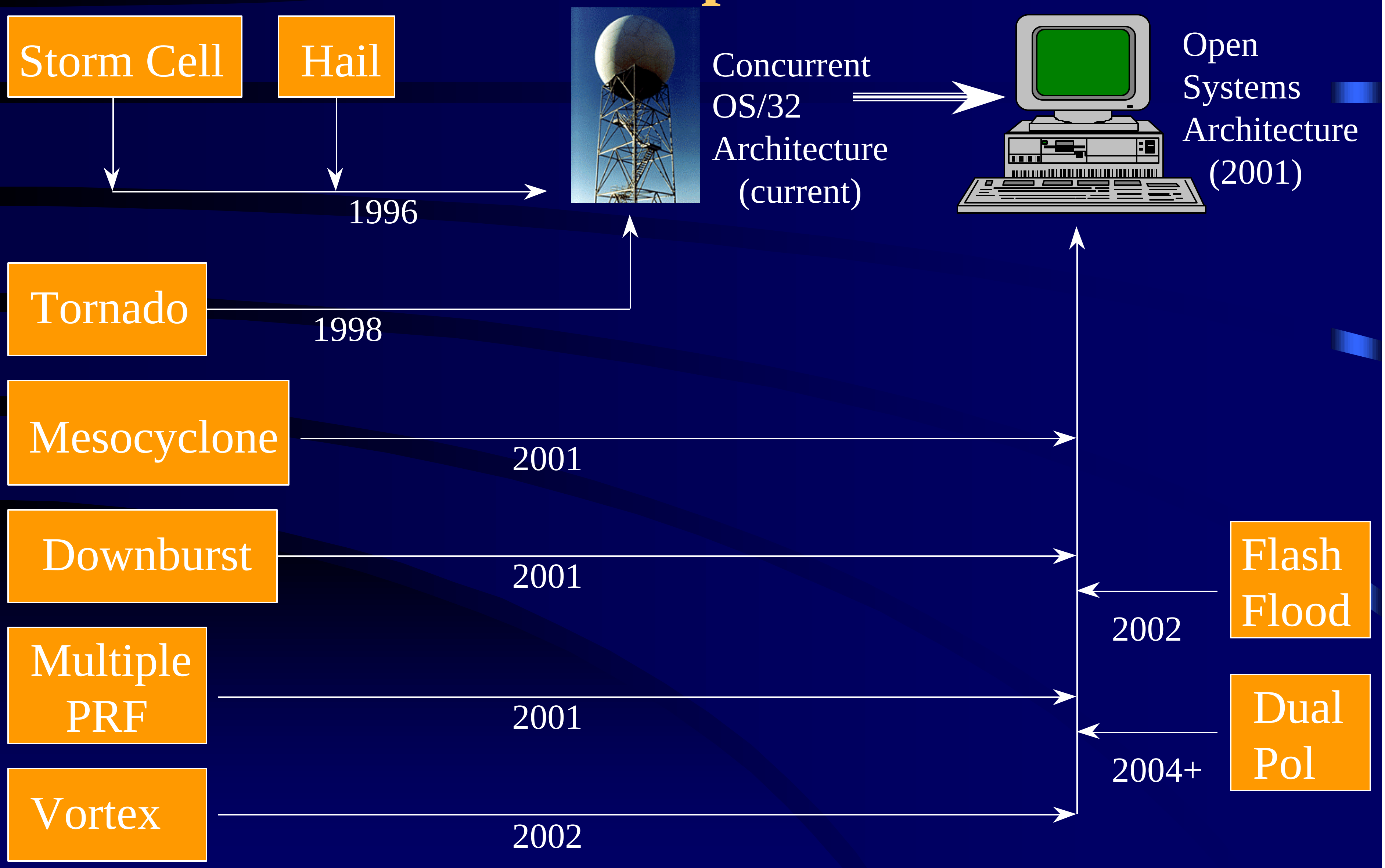
Reflectivity
-Large Values indicate strong echo power

Differential Reflectivity
- **Large values indicate melting snow**
- **Moderate values indicate rain**
- **Small values indicate dry snow**



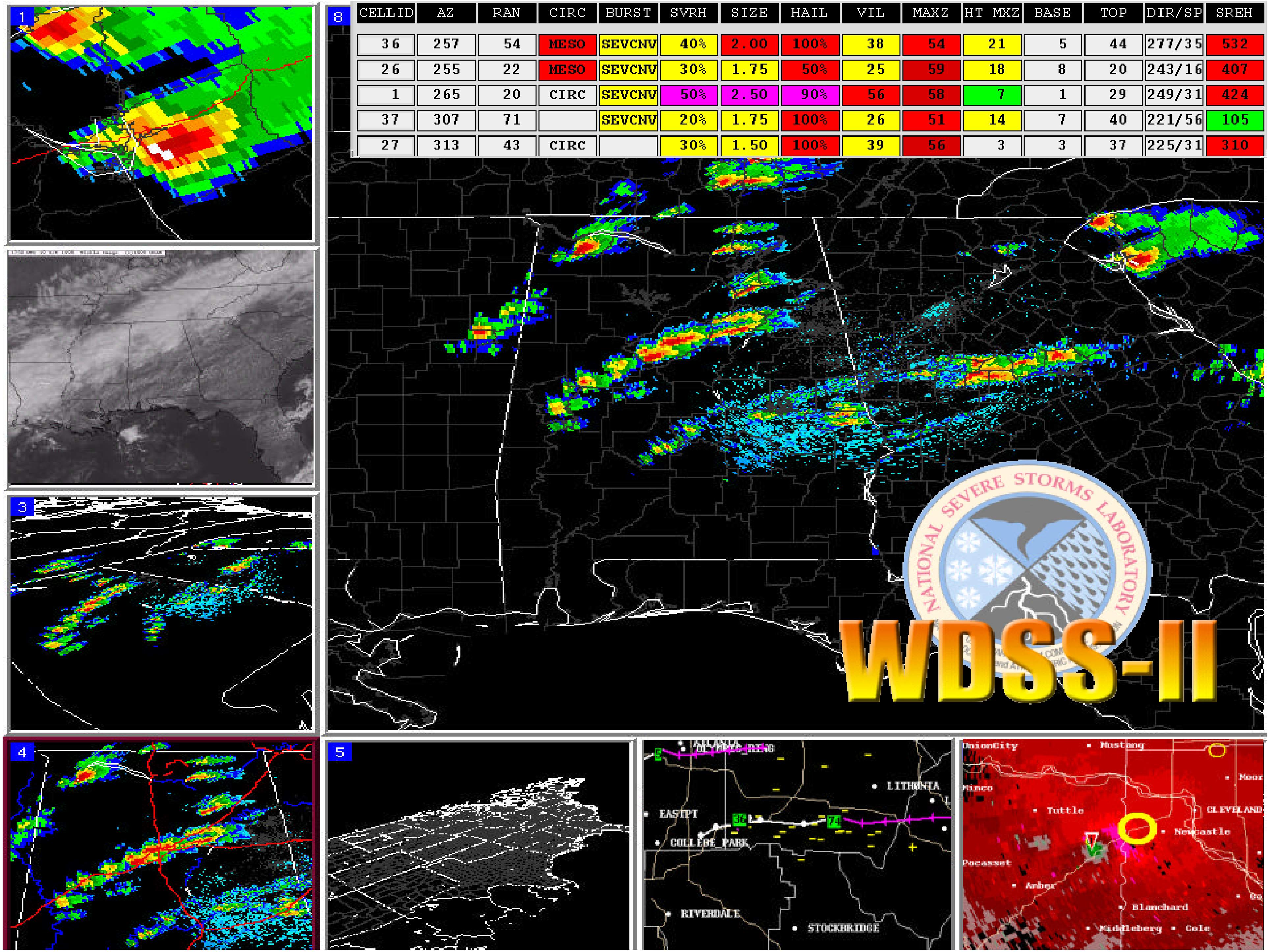


NSSL Algorithms
Path to Operations



NSSL is the R&D Leader for the NEXRAD Program

- NSSL has a broad base of expertise that allows us to take research ideas all the way to operational systems and applications
  - Meteorological Expertise
  - Image Processing Expertise
  - Severe and Hazardous Weather Detection and Short-Term Prediction
  - Engineering Expertise
  - Software Engineering Expertise
- A number of applications that NSSL has developed could be adapted for ITS.

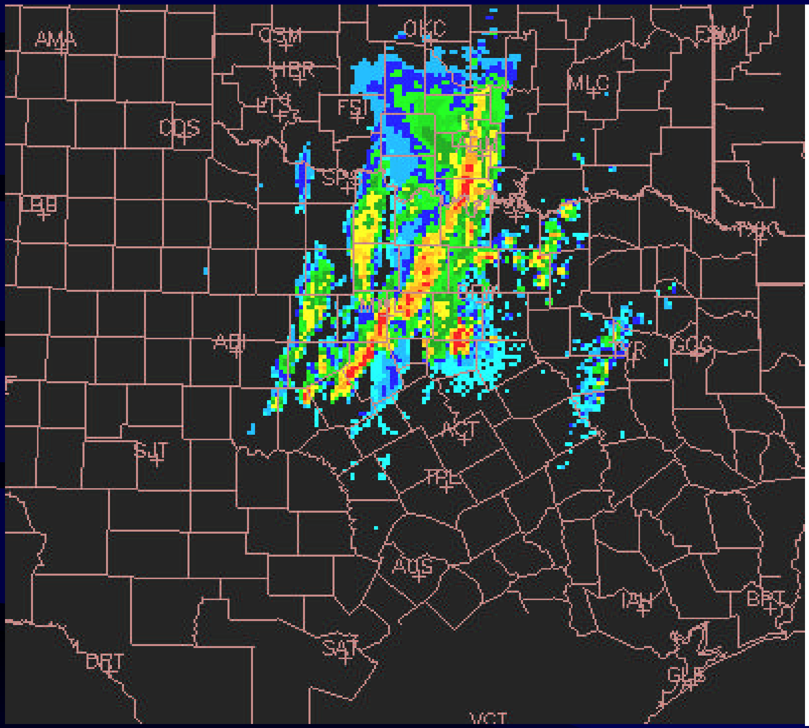


1
8

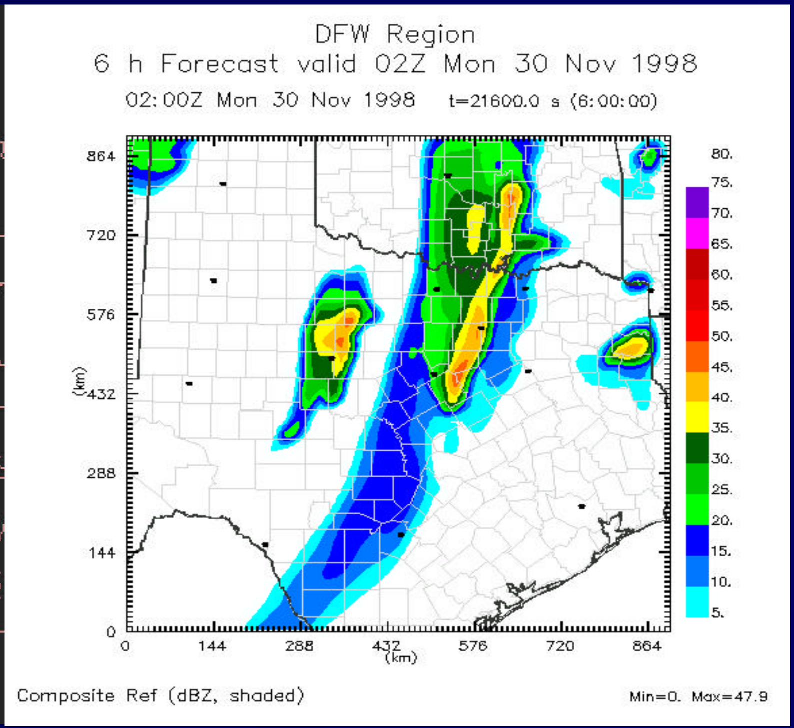
CELLID	AZ	RAN	CIRC	BURST	SVRH	SIZE	HAIL	VIL	MAXZ	HT MXZ	BASE	TOP	DIR/SP	SREH
36	257	54	MESO	SEVCNV	40%	2.00	100%	38	54	21	5	44	277/35	532
26	255	22	MESO	SEVCNV	30%	1.75	50%	25	59	18	8	20	243/16	407
1	265	20	CIRC	SEVCNV	50%	2.50	90%	56	58	7	1	29	249/31	424
37	307	71		SEVCNV	20%	1.75	100%	26	51	14	7	40	221/56	105
27	313	43	CIRC		30%	1.50	100%	39	56	3	3	37	225/31	310

NATIONAL SEVERE STORMS LABORATORY
WDSS-II
3
4
5
LITHONIA
EASTPT
COLLEGE_PARK
RIVERDALE
STOCKBRIDGE
UnionCity
Mustang
Minco
Tuttle
CLEVELAND
Newcastle
Pocasset
Amber
Blanchard
Middleberg
Cole

Sample Operational 9 km ARPS Forecast From Center for Analysis and Prediction of Storms (CAPS)

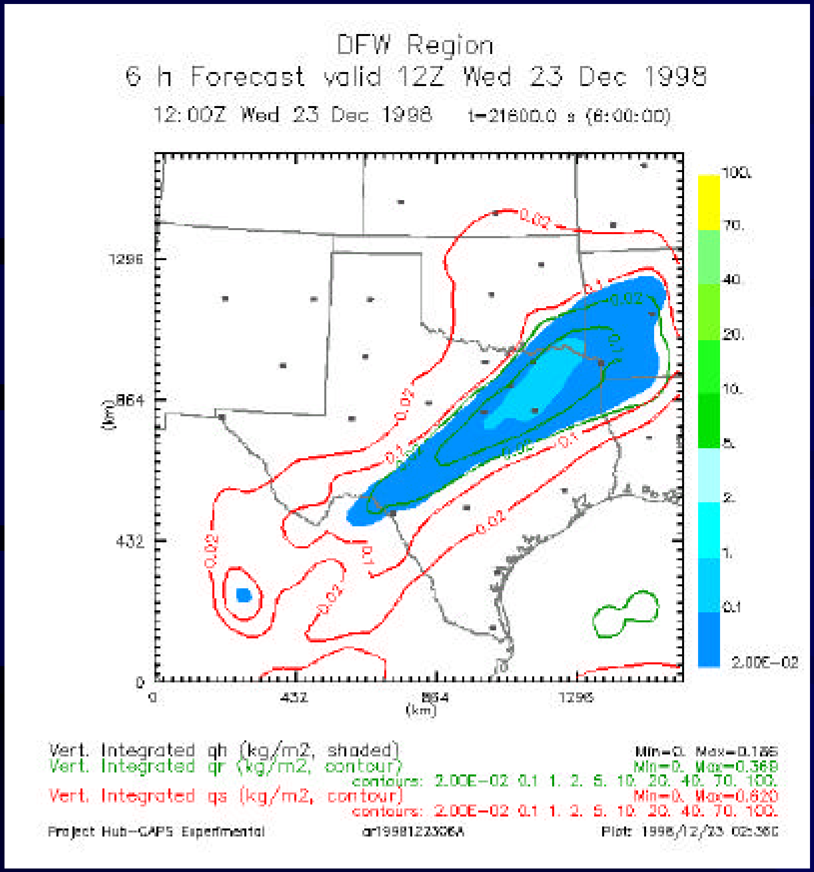


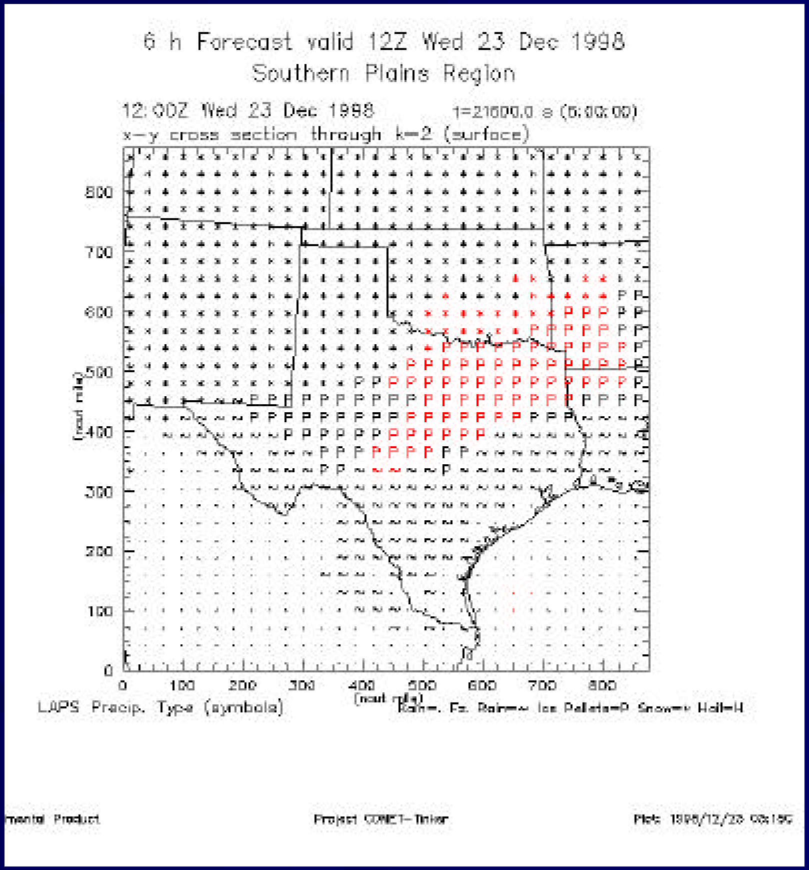
Fort Worth Radar at 02Z on 11/30/98



ARPS 6-hour, 9 km Resolution Forecast Valid at 02Z on 11/30/98

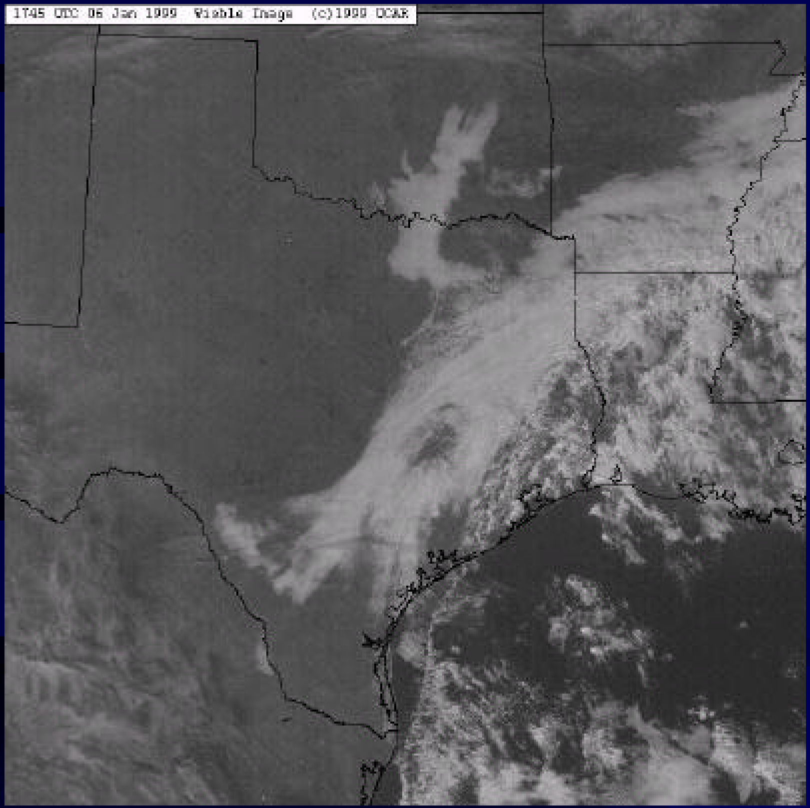
23 December 1998



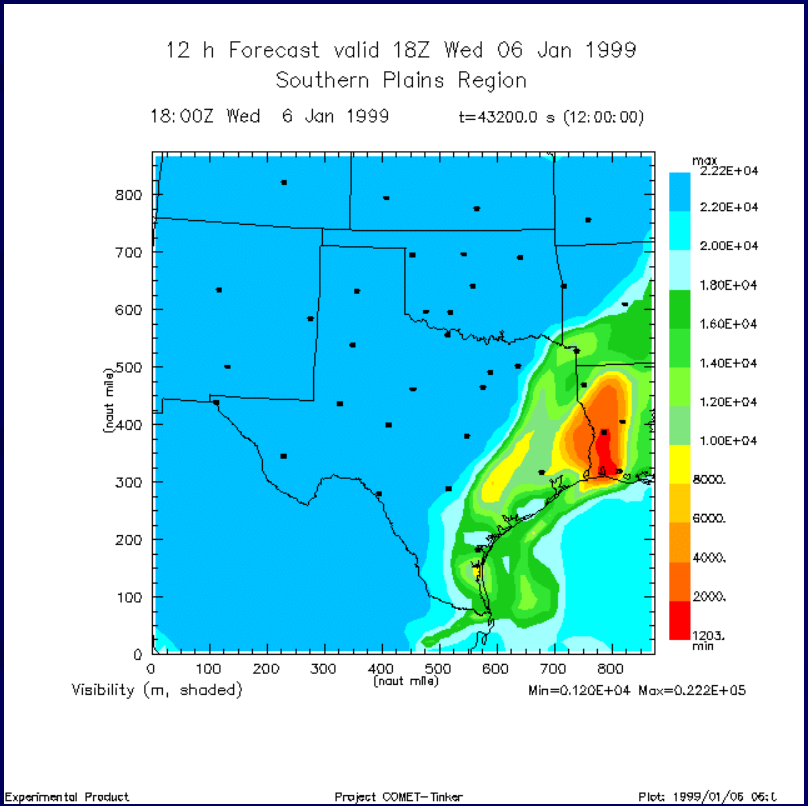


ARPS 6 h Forecast Explicit (left) and Conditional (right) Precipitation Type (27 km) Valid 12Z 23 Dec 98

6 January 1999



GOES Visible Image
1745Z, 6 Jan 99



ARPS 12 h Forecast Visibility
(27 km) Valid 18Z, 6 Jan 99

Thank You!

The Role of Advanced Signal Detection Techniques in the Development of High-resolution, Accurate Decision Support Systems

Presented by

Richard A. Wagoner
Program Development Manager
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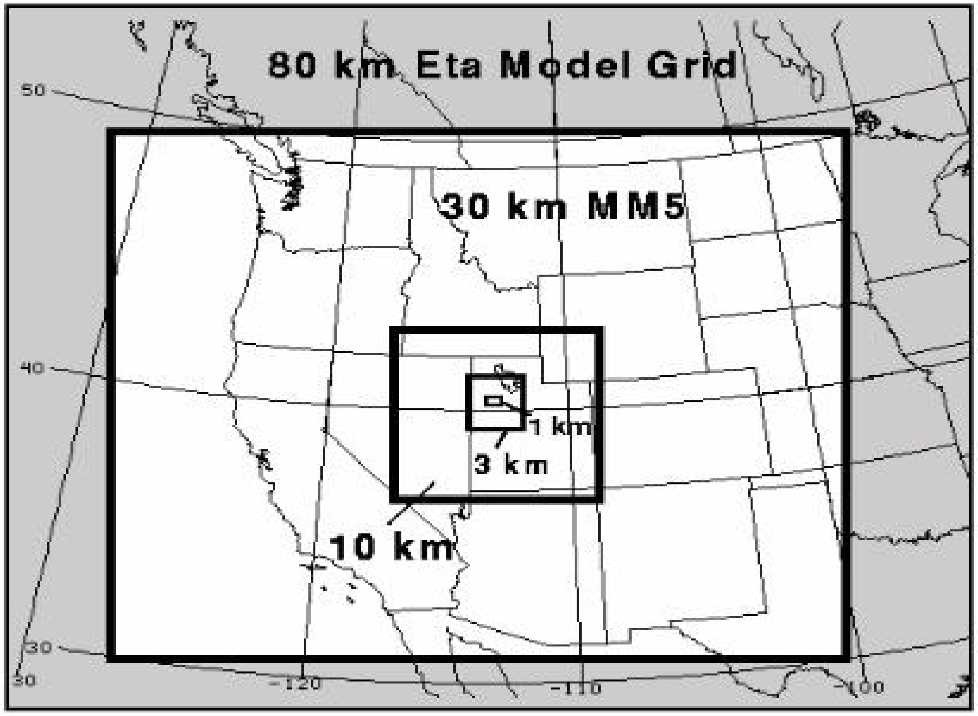
Symposium on Weather Information for Surface Transportation
2 December 1999
Silver Spring, Maryland

NCAR Applications of Numerical Modeling to Decision Support Systems

- Co-developer of the MM5 mesoscale model
- NCAR uses mesoscale model in all DSS's
- Currently running highest resolution operational model in the world (Army test ranges)

West Desert Test Center



MODEL CONFIGURATION

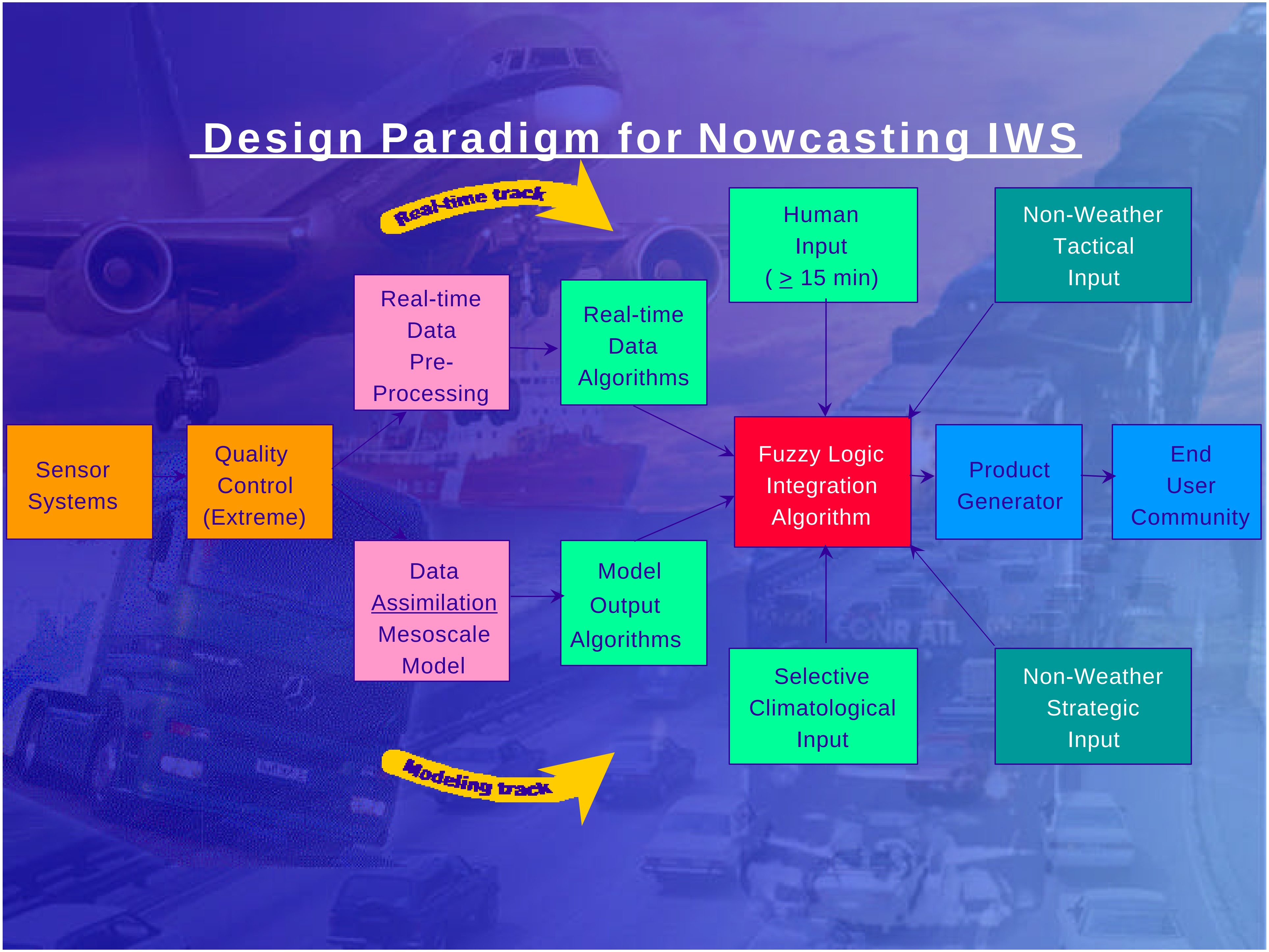
Grid	# Grid Pts	Grid Size	# Sfc Obs
Domain 1	98 x 64	30 km	> 200
Domain 2	70 x 67	10 km	> 100
Domain 3	61 x 61	3.3 km	29(64)
Domain 4	37 x 28	1.1 km	11

The Problem: Detect a Weak Signal in a Noisy Environment

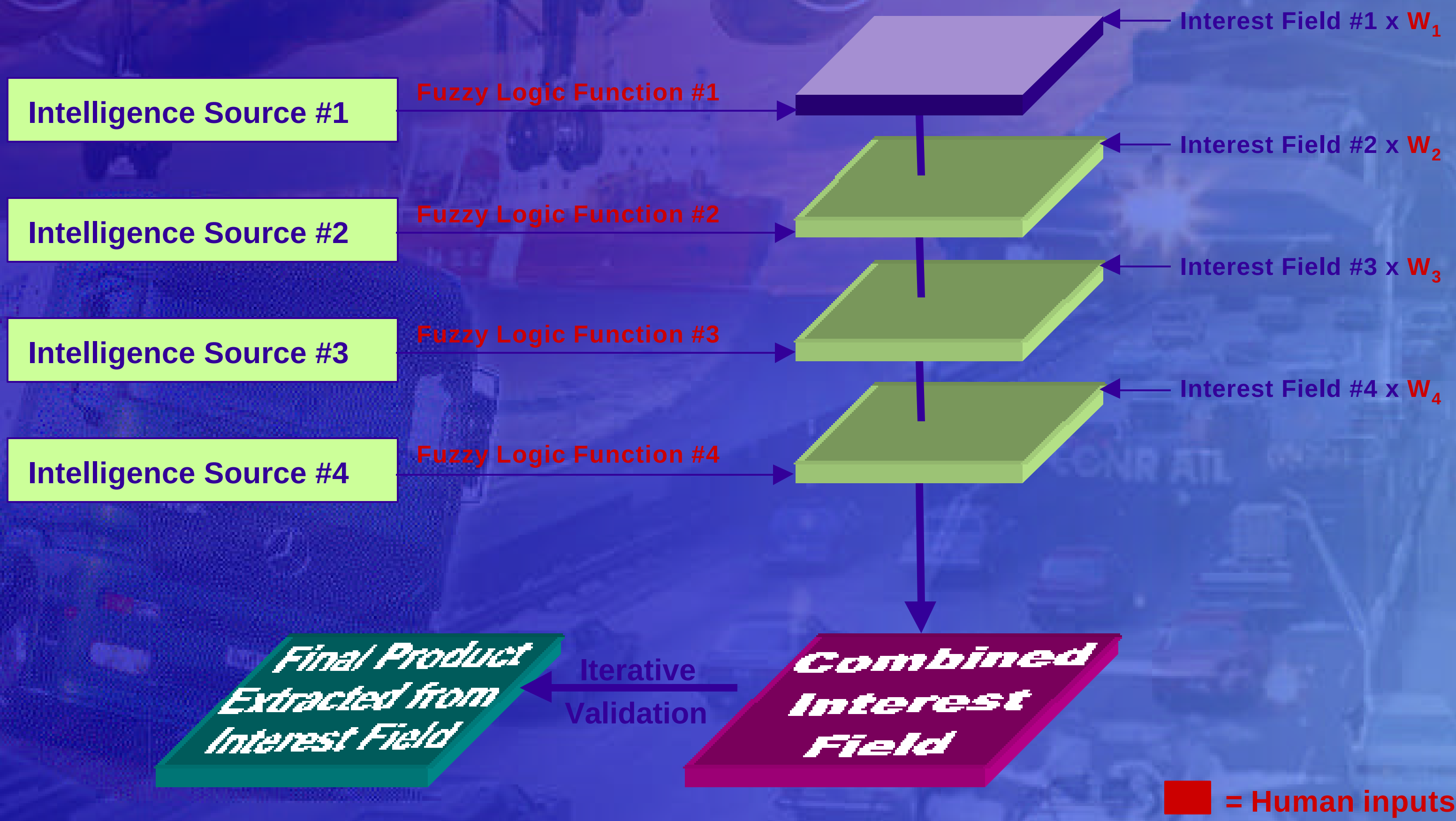
- **Example 1: Detect intense, fine-scale thunderstorm that may be producing a local flash flood or debris flow**

- **Example 2: Detect presence of all 1-mile road segments that have visibilities below a set threshold**

- **Example 3: Detect presence of precipitation on all 1-mile road segments**


Design Paradigm for Nowcasting IWS
Real-time track
Modeling track
Sensor Systems
Quality Control (Extreme)
Real-time Data Pre-Processing
Data Assimilation Mesoscale Model
Real-time Data Algorithms
Model Output Algorithms
Human Input (≥ 15 min)
Non-Weather Tactical Input
Fuzzy Logic Integration Algorithm
Selective Climatological Input
Non-Weather Strategic Input
Product Generator
End User Community

Fuzzy Logic Mapping/Merging of Intelligence Sources & Product Extraction



How Fuzzy Logic Differs from Statistical Methods

- Statistical methods are derived from Boolean Logic and thus require classification of data (yes or no)
- Fuzzy logic allows continuous values; no classification required; functions derived from human experts

Characteristics of Intelligent Weather Systems

- **Semi-automated or fully automated**
- **Mimics human forecaster process**
- **Based on synthesis of data from multiple weather sensors and numerical weather models**
- **Quality control of weather data is robust and comprehensive**
- **Precision detection of weather events in space and time***
  - Probability of detection ≥ 90%
  - False alarm rate (over-warning) ≤10%
  - Space resolution about 1 mile
  - Time resolution about 1 minute

*Data-rich areas

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